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Table of Contents

APRIL, 1933

The Journal

Glass as a Structural and Stress-Resisting Material—Preston 163
The Use of Sucrose in Sand-Lime Brick—Hamor, Cox, Metschl, and Van Brunt .. 187
Enamels of Standard Colors for Vitreous China Sanitary Ware at Cone 6—Kautz . 192
A Fusion Study of the High Feldspar Area in the Feldspar–Kaolin–Quartz System—Waldschmidt 199

Ceramic Abstracts

135

The Bulletin

Editorial
How to Value Our Society 79
Papers and Discussions
Research and Human Welfare—Poste 81
Research—A Factor in Competition—Spraragen 83
A Proposal for Correlation of Ceramic Research—McKinley 89
The Organization and Function of the Research Committees of the American Ceramic Society—Twells 92
Activities of the Society
Our Thirty-Fifth Annual Meeting 95
Historical Data on the American Ceramic Society 95
Report of the Publications Committee, American Ceramic Society, 1932–1933 96
Report of the Committee on Geological Surveys for 1932 97
Standards Committee Report 99
Proposed Constitutional and By-Law Amendments, American Ceramic Society 100
Annual Report of the Glass Division, American Ceramic Society for 1932–1933 104
Minutes of the Refractories Division, American Ceramic Society 105
Report of Representative of Refractories Division Committee on Standards, Subcommittee on Tests 106
White Wares Division Advisory Committee to the Bureau of Standards 106
Local Section Annual Reports:
Baltimore-Washington, Chicago, Pacific Northwest, Pittsburgh, and St. Louis Sections 108–111
Research Studies at the Ceramic Schools:
New York State College of Ceramics (at Alfred University), Ohio State University, University of Washington, and Virginia Polytechnic Institute 111–112
American Ceramic Society Student Branch Activities Annual Report:
Iowa State College and New York State College of Ceramics 113
Ohio State University, Pennsylvania State College, and Rutgers University 114
School of Mines & Metallurgy, Rolla, Mo., and University of Illinois 115
University of North Carolina, State College of Agriculture & Engineering at Raleigh and University of Washington 116
Informal Reception and Smoker by Officers of the American Ceramic Society to Student Delegates 117
First Annual Mineral Industries Conference 117
Exhibit of the American Tableware at Ohio State University 118
Necrology—: Francis W. Walker, Sr., 1855–1933 118
New Members Received in February 120
Advertiser's Index 13

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GLASS AS A STRUCTURAL AND STRESS-RESISTING MATERIAL*

By F. W. Preston

ABSTRACT

A collection of notes on the stresses set up in glassware of various sorts by various forces and treatments is presented, with some observations on how the stresses act to produce failure.

I. Introduction

At frequent intervals glass manufacturers are faced with the question as to how strong glass is (or should be) in some particular form or other. For instance, the question may be, how large a sheet of glass of given thickness can be and still withstand specified winds or snow loads. Or the question may concern the strength of tubing or bottles subjected to internal pressures. There are a variety of other questions that may arise, and though most of them can be answered by reference to the fundamental works on the strength and elasticity of materials, it may be convenient to assemble in one place an abstract of the whole matter.

This, perhaps, is the more the case since the forms in which glass is used are not those most commonly met in steel practice. Window panes are examples of slabs supported all round, but this is not the commonest, nor the best understood, form of steel construction. Corrugated wire glass for roofing is a structural form not encountered by the steel engineer. On the other hand, glass is rarely used in torsion, nor is it commonly worked into I beams which occupy so much attention of the steel engineer

A selection accordingly has been made of the cases that seem most relevant, and the subject is developed from first principles since glass men as a rule do not claim to understand the subject at all well.

It has not appeared to me necessary or desirable to confine attention to work already published. Thus there are included in this paper brief résumés of various matters that seem directly relevant, whether the work has been published previously or not.

II. Comparison of Structural Glass Forms with Structural Steel Forms

Round steel bars are usually tie bars intended to brace a truss as tension members or they are torsion members (line shafts, etc.). Round glass rods are scarcely used *structurally* either as tension or torsion members, though they may be used in this form for *testing* in either way.

Circular section steel tubes may be hollow torsion shafts, as in the propeller shafts of ships (glass is not used in this way); or they may be cylinders for resisting internal pressure as in steam and hydraulic devices. Glass is called on to withstand internal pressure in gage glasses and many bottles. Occasionally steel tubes are used as compression members, and glass, perhaps still more rarely, for the same purpose. Both glass and steel tubes may be called on to function as conduits and incidentally to carry flexing loads.

Glass, as we have seen, is rarely, at the present time, used in the characteristic structural forms of I, H, or T bars. If it were, the usual formulas applicable to steel would be directly applicable to glass, and we should no

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* Presented at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (Glass Division). Received December 27, 1932.

doubt have "standard sections" and tabulated moments of inertia and section moduli.

Glass is not used structurally as a cantilever, though it may occasionally be tested as such. Even this use is unusual, and it may be said that glass is invariably used as a bressumer, that is, as a beam supported at both ends, if it is a flexure-resisting member.

Moreover, in the great majority of cases sheet glass is supported all round the rim, whether it be circular (as a ship's porthole light) or rectangular (as an ordinary window pane). Steel is not often used or computed for in this form since a sheet is a poor flexure-resisting form, and if any strength at all is needed the steel man rivets on a few stiffening angles, tees, or channels. With glass, riveting is not a great success and the corresponding practice is to cut the sheet into several smaller sheets and use stiffening members of wood or metal, the smaller glass sheets being used as before, as plain slabs supported all around.

An exception is corrugated structural glass, which is supported at two sides (ends) only, and acts as a simple bressumer.

In testing for flexural strength, the simple bressumer form is the rule.

Steel structural forms are generally adapted to carry concentrated loads, that is, the load may often be applied at a particular spot; for instance, in a bridge crane, the load to be lifted by the crane hook is transferred to the bridge at a point directly over the hook. The load of floors is generally transmitted, in the ultimate analysis, to the main girders where the secondary girders rest on them. With glass, on the other hand, the normal form of loading is a uniform pressure or weight per square foot of area. The pressure may be simply the dead weight of the glass itself, the pressure of the wind, or the weight of snow on a skylight. Concentrated loads are usually unintentional, arising perhaps from pinching in a sash or something of that sort.

In rare instances, the pressure, instead of being uniform, increases linearly from top to bottom, as in plate glass forming the sides of large aquariums.

On the other hand, in testing the flexural strength of glass, the use of a concentrated load is convenient, and the commonest test of glass is made by supporting a lath as a bressumer, and loading it with a concentrated load at the mid-span.

Bressumers may be, and sometimes are, tested by distributed loads, but this is unusual, and sometimes difficult. Panes of glass may be tested while supported all around and loaded with a uniformly distributed load.

III. Forces, Bending Moments, and Stresses

The physical world is described very largely in terms of length, time, and force. These quantities themselves can not be described intelligibly, or reduced to simpler concepts; one is supposed to have an idea, more or less spontaneously, of what an inch, a second, and a pound weight look or feel like. In metric countries the units are the millimeter, the second, and the kilogram weight.

The academic units, the centimeter, second, and gram (mass) are not used.

In what follows we shall use the accepted English (engineering) units,

viz., the inch of length, the second of time, and the pound weight of force.

(1) Force A lump of iron, marked one pound and certified to be one pound, if placed on the hand or the table, exercises a force of approximately one pound weight on the hand or the table, provided the hand or table is kept still. The force experienced is slightly greater at the pole than at the equator. It is less at the top of a mountain than at sea level, and much less on the moon. It is much greater if one tries to accelerate the lump of iron, as for instance in throwing it at the cat. We shall assume, however, that the reader is familiar with the force exerted by a quiescent one pound lump, and since this force is for all ordinary purposes the same at all accessible parts of the earth, we shall not discuss it further. The pull of a spring balance with the pointer indicating one pound, is likewise a *force* of one pound. The inch and the second need no comment.

(2) Bending Moments A pound weight may be supported readily enough on the palm of the outstretched hand, but if the pound weight be a fish at the end of a long fishing-rod, it would be tiresome to hold it extended for long. Consequently fishermen always have their fish close to them when posing for photographs, though they would like to have them nearer the camera to magnify their apparent size. The tiresomeness of supporting the fish is directly proportional to the length of the rod, and arises from the bending moment exerted by the fish at so great a leverage. This moment tending to bend the arm down is measured by the product of the weight of the fish ($= W$ pounds weight) and the length of rod ($= l$ inches) or M (moment) $= Wl$.

We have supposed the rod to be extended in line with the arm so that its action tends to bend the arm; the moment is then a *bending moment*. If the rod had been extended at right angles to the arm so that its tendency was to twist the wrist, we should have spoken of it as a twisting moment, a torsional moment, or simply a *torque*. It will be evident from this illustration that the distinction between a torque and a bending moment is nebulous, and is essentially a question of how one looks at it. In general we call a thing a torque if its tendency is to rotate something resembling a shaft or a tube around its longitudinal axis. If the tendency is to flex the thing, bending an otherwise straight object such as a shaft or beam out of line, we call it a bending moment.

(3) Stresses The one pound weight on the palm of the hand is probably pressing on several square inches of skin. If it is uniformly distributed over these square inches, then the weight divided by the area gives the *pressure* per square inch. A pressure, thus defined, is a *stress;* in fact a pressure is a *compressive stress*. A boiler carrying 800 "pounds of steam" is carrying 800 pounds per square inch of steam pressure. This is the compressive stress in the steam, and it is also the pressure exerted against each square inch of the boiler shell on its inner face. The outer face of the shell carries the atmospheric pressure, 14 pounds per square inch. And if the truth were known, the inside carries 814. But we are generally interested only in the excess internal pressure, *viz.*, the net 800.

The boiler tends to burst; it is therefore made of steel, and the steel has to resist the stretching to which it is subjected by the steam. The boiler is expanded slightly above its proper size by this stretch, and its fibers are under a *tensile* stress in the direction of the periphery, in fact in

two directions in the plane of the shell. The shell, in short, is being stretched longitudinally and also circumferentially by *tensile stresses*. These may be 5000 and 10,000 pounds per square inch, respectively.

When the stresses are thus unequal in two directions *shearing stresses* are set up also.

If we take an egg and gently drop it inside a boiler, it is squeezed inward in all directions by a pressure of 800 pounds per square inch. It may break as the shell is thin. Suppose we use a pot egg, that is, a dummy egg used to beguile the innocent fowl, but useful also for this experiment. It is a solid lump of homogeneous porcelain. A cube of porcelain would do equally well. It is subjected to a compression of equal amount on all its faces and throughout its mass. At any point the stress is 800 pounds per square inch and it is the same in all directions through this point. Every little grain of porcelain experiences this same uniform and isotropic pressure. A fish 2000 feet beneath the surface of the sea lives in a medium of this sort. But as long as the pressure is uniform in all directions (that is, as long as it is "isotropic") there are no shearing stresses set up. The top of the egg does not tend to slide off the bottom half.

Again if we could stretch the egg uniformly in all directions, applying an isotropic *tensile* stress, we should have no shear. The egg might come apart, but the parts would come directly away from one another. They would not slide over one another. Those stresses that act on a surface within the material in such a way that the material on one side of the plane tends to slide over the material on the other side of the plane, without the plane opening as a crack, are shearing stresses. They are also called tangential stresses. Those stresses that act across the surface are called the "direct" stresses, compression or tension. Tension tends to cause rips, tears, or cracks. Compression of itself does nothing of much consequence. With porous or feeble materials like wood it may cause a permanent increase of apparent density, but it does not cause fracture of any sort.

In this last paragraph we are referring to isotropic tensions and compressions. There is no such thing as isotropic shear. There must always be some planes or directions in a material that are free from shear stress, however we stress it. There are two planes or directions in which the shear reaches (equal) maximum values. These two planes are at right angles to each other. There are necessarily two such planes and no more. On planes bisecting the angle between these two there is no shearing stress.

Let us confine ourselves to two-dimensional cases for the time being (Fig. 1). If the greatest direct stress (say tension) is in the direction T_1, and there is a second small tension T_2, then there will be shear on any plane which does not contain either the T_1 or the T_2 axis. For instance, there is shear on the 45° plane, PQ. But the largest shear would be on a plane inclined at 45° to the plane of the paper and passing through the paper on the T_2 axis. There are of course two such planes, one showing above the paper to the north of T_2, the other showing above the paper to the south of this, and the two planes being at right angles to each other and at 45° to T_1.

If the stress T_2 had been a compression, the plane PQ would have experienced the greatest shearing stress, and there would have been another whose intersection with the paper would run NW to SE.

The reason is that the plane of greatest shear bisects the angles between those principal stresses whose algebraical difference is greatest. We have

supposed that the T_3 stress (that tension or compression at right angles to the paper) is zero. The difference $T_1 - T_3$ is greater than $T_1 - T_2$ if T_3 is a tension (*i.e.*, if it has the same sign as T_1) and less if T_2 is a compression (*i.e.*, if it has algebraically the opposite sign).

We have injected this discussion of the several sorts of stress, and in particular the discussion of shear stresses, mainly to bring out the relations between them. As glass never fails (in the cold state) by reason of any stress but tension, we shall not have so much use for detailed discussion of shear and compressive stresses. But it is desirable that it be recognized that tension or compression (when it is isotropic or hydrostatic) may exist without shear, but that shear can not exist without compression or tension or both. And further that shear itself can not be isotropic, but vanishes on planes at 45° to those on which it is a maximum. These planes of zero shear are the planes on which the direct stresses (tension or compression) reach their maximum values. They are called the planes of principal stress.

IV. The Cause of Failure

It will be stated here categorically that glass fractures are always rips or tears, that is, tensile failures. Thus we need not normally interest ourselves in shear stresses or compressive stresses, because these do no damage of themselves.

It is a matter of common knowledge that a piece of paper can be readily torn in two if the rip is started at an edge, but it is hard to tear the paper from the center outward. In the same way, and possibly for somewhat similar reasons, it is easy to crack glass from the outside, but difficult to crack it from the inside. By "inside" we mean "within the mass of the glass," not "from an interior surface." If there be interior surfaces, such as the inner face of a gage glass or bottle, or the contact between wire and glass in wire glass, such surfaces are effectively "outside" the mass of the glass and are as tender as any other outside. Even bubbles seem to be sources of weakness at times. The point, however, is, that a fracture will usually take place from an outer face, and therefore demands a *tension* at a face. In the absence of a facial tension, glass is exceedingly strong.

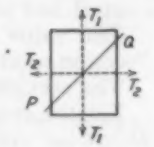

FIG. 1.

The numerical value of the tension that must be developed to cause fracture is a most erratic quantity. Over tiny areas it may be many score thousand pounds per square inch. Over large areas it may not be so much as 5000 pounds per square inch. Normal results from common methods of testing (usually by flexing laths) give values from 5000 or less up to 9000 or more (pounds per square inch).

V. Glass in Simple Tension

A rod, stick, or bar of glass carrying a load of W pounds weight and of cross-sectional area A is supporting an average tensile stress of W/A pounds per square inch. The actual value of the stress at any point will depart from this, perhaps quite considerably, if the load be not placed to pull truly on the axis of the rod. The axis of the rod is the center of gravity of the cross-section. If the pull of the load W be eccentric to this center of gravity by a distance E inches, then it exerts on the cross-section not only a pull, W, but a moment, WE. The average stress is still W/A,

due to the pull, but in parts it is less and in other parts more, being greatest at the margin of the specimen nearest the line of pull, where the additional load is My/I. M is the moment WE, I, the sectional "moment of inertia" talked of below, and y, the distance of the margin in question from the center of gravity. I/y is also called Z, the section modulus. The total tensile stress is then $W/A + WE/Z$, at the most heavily stressed point.

VI. Simple Bending of Laths

Structural glass (plate, window, and wire) is usually tested by cutting a lath from a sheet, setting the two ends on two knife edges, and applying a load W on a knife edge or its equivalent midway between the two end supports.

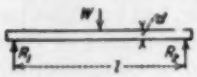

FIG. 2.

For glass that is not commonly worked into sheets, a rod may be drawn from the melt and tested in bending by essentially the same set-up.

The bending moment is greatest at the center of the span, directly under the load W, where it amounts to $R_1 \times l/2$ and since $R_1 = R_2 = W/2$, the value of M_{max} is $Wl/4$ (see Fig. 2).

This value of M is correct whether we are dealing with rods or laths, and whether the rod is of uniform section or not; it assumes only that W is central and is a concentrated load.

The value of the stress reaches a maximum of M/Z, where Z is the "section modulus."

The section modulus is defined as follows:

Let the cross-section appear as in Fig. 3, of any shape, but symmetrical about the vertical axis, and let xx_1 be a horizontal line through the center of gravity of the section. Then xx_1 is called the neutral axis, because the bending of the beam produces no stress at this level. The stress due to bending is a compression above this line, increasing uniformly as we go upward, and a tension below the line, increasing uniformly as we go downward. Call the stress (tension) f. Then $f = ky$ (see Fig. 3). This *stress* acting over the area $x \cdot dy$ gives a *force* of $kxy \cdot dy$. This force, acting around the center of gravity with a lever arm, gives a *moment*, $kx \cdot y^2 dy$. The total moment exerted by all such stresses is $\int kx \cdot y^2 dy$. The integral is taken over the whole cross-section, both above and below the line xx_1.

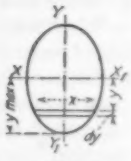

FIG. 3.

The integral is of course itself a "moment," and is called the "moment of resistance" of the cross-section. It is necessarily equal to the bending moment imposed from outside. In other words, the moment of resistance is that internal moment of stresses which opposes and supports and equilibrates the external moment of loads. Since k is constant, it goes outside the integral sign.

Thus,

$$M = k \int xy^2 dy \qquad (1)$$

$\int xy^2 dy$ = "moment of inertia" of cross-section (it is the sum of all the elements of area dA ($= xdy$) multiplied by the square of the leverage arm (y^2)).

The "moment of inertia" of a section is a purely geometrical quantity, and has no relation whatever to the bending moment or the moment of resistance, except through the factor k. In other words, a rod or lath, once made, has a particular value of I (moment of inertia) by reason of its size

and shape, and this is not changed in any way by the bending moment applied or the moments of resistance called into play.

The value of k alone changes with increasing bending moment.

We wrote $f = ky$. Therefore $f_{max} = k \cdot y_{max}$ (see Fig. 3). (2)

or $$k = f_{max}/y_{max}$$

But from equation (1) $$k = M/I$$

So $$\frac{M}{I} = \frac{f}{y} = \frac{f_{max}}{y_{max}}$$

Most of the sections we need to consider are squares, circles, and rectangles, so that y_{max} equals half the total depth of the section; also f_{max} is simply f_s, the "skin" stress.

Thus $$\frac{M}{I} = \frac{f_s}{d/2} \tag{3}$$

Now I is known from geometrical inspection and the same is true of $d/2$ (see Fig. 4).

M we know from the external loading. Therefore this equation enables us to determine f_s or f_{max}, which is what we generally want to know, *viz.*,

$$f_s = f_{max} = \frac{M}{I} \cdot \frac{d}{2} \tag{4}$$

The stress at any other level than that of the skin is $f = \frac{M}{I} \cdot y$.

I divided by y_{max} or $d/2$ is called Z the "section modulus." This also is obviously a purely geometrical quantity.

Using this nomenclature $f_s = M/Z$ (5)

This is the most important formula in the theory of bending beams. It is valid not only for the concentrated central load we have spoken of, but for any beam, however loaded. The value of M must be found from the loading, and when M is found, f can be calculated from this formula.

FIG. 4.

Since the only sections of regular occurrence in glass work are the rectangle and circle, the values of Z are given (see Figs. 3 and 4).

Rectangle $Z = bd^2/6$ $\qquad I = bd^3/12$

Circle $Z = \frac{\pi}{4} R^3 = \frac{\pi d^3}{32}$ $\qquad I = \frac{\pi}{4} \cdot R^4 = \frac{\pi d^4}{64}$

These moments of inertia and section moduli apply to flexing loads. The values for torsional moments are greater. The "polar" moments of inertia are $(bd^3/12 + db^3/12)$ and $(\pi d^4/32)$, respectively.

In looking up such quantities in books of tables, it is necessary to be careful to note whether polar moments are being tabulated or the values for flexures.

FIG. 5.

VII. Deflections

A loaded beam can only develop a moment of resistance by deflecting. It deflects until the stretching and compressing of its fibers produce a moment of resistance capable of equilibrating the external bending moment.

Consider a beam bent, by appropriate means, to a true circle of radius R (see Fig. 6). R is measured to the neutral axis. The neutral axis is "neutral" by definition since it carries neither tension nor compression. In other words it is neither stretched nor shortened. It is of the same length as it was originally. That is, AB is of its natural length, while CD has been stretched. CD was originally (when the beam was straight) just as long as AB was, or as AB now is. AB is obviously $R\theta$. CD is $(R + d/2)\theta$.

FIG. 6.

The stretch of $CD = \theta \cdot d/2$ (on an initial length of $\theta \cdot R$). "Strain" is accordingly $d/2 \div R$.

Stress is $E \times d/2 \div R$, where E is Young's modulus, or $f_s = \frac{E}{R} \cdot \frac{d}{2}$. (6)

Combining this with equation (3) or (5)

$$\frac{f_s}{d/2} = \frac{f}{y} = \frac{M}{I} = \frac{E}{R} \tag{7}$$

The whole essence of the theory of beams is contained and condensed in this equation.

The curvature $(1/R)$ induced in beams of steel or glass by loading is always quite small: the beam does not deflect a great deal. The neutral axis is a curve that is all but flat and straight.

$$\text{The curvature of a line} = \frac{1}{R} = \frac{d^2y/dx^2}{\left\{1 + \left(\frac{dy}{dx}\right)^2\right\}^{3/2}}.$$

$$\text{When the line is nearly flat this becomes } \frac{1}{R} = \frac{d^2y}{dx^2} \tag{8}$$

y is a measure of deflection and x of the distance along the span.

$$\text{Thus } \frac{d^2y}{dx^2} = \textit{curvature} \text{ of beam} = \frac{1}{R} = \frac{M}{EI} \tag{9}$$

$$\frac{dy}{dx} = \textit{slope} \text{ of the beam} = \int \frac{M}{EI} \cdot dx \tag{10}$$

$$y = \textit{deflection} \text{ of the beam} = \iint \frac{M}{EI} \cdot dx \cdot dx. \tag{11}$$

M is usually a function of x, but the integration is usually easy, and the limits between which the integration is to be effected are known. We shall not here perform the integrations but shall simply give the results of two of them.

(1) Concentrated load at center of span; deflection at center $= \delta = \frac{Wl^3}{48\,EI}$ (12)

(2) Uniformly distributed load over whole span; deflection at center

$$\delta = \frac{5\,Wl^3}{384\,EI} \tag{13}$$

Measuring such deflections is a fairly good way of arriving at a value of E for the glass. W, l, and I can usually be determined with accuracy. δ can be measured with fair accuracy, especially if the span be long. Hence E can be found.

If Young's modulus is known for that sort of glass (and it is usually about 10 million pounds weight per square inch) a measurement of the deflection serves to determine the value of I in cases where some doubt might attach to its measurement by direct inspection. For instance, the value of I for corrugated wire glass can be approximately calculated by purely geometrical means, but it can be determined with greater accuracy, in all probability, by a deflection measurement.

VIII. Calculation of Bending Moments

The calculation of bending moments is one of the most important operations of engineering theory. At times it is very difficult. For instance, it is difficult to calculate the bending moments in some sorts of arches, so much so that great bridges are commonly made with two or three hinges, one at each abutment and one (sometimes) in the center of the span. The bending moments must vanish at the hinges, since the hinge can offer no moment of resistance, and by ensuring this the bending moment becomes calculable at other points of the span.

Again, if a beam rests on two supports, the bending moment can be readily calculated at any point for any given loading, but if the beam rests on three supports in line, the calculation becomes comparatively difficult. The Theorem of Three Moments is involved, and a slight displacement or settling of any one of the three supports entirely upsets the calculation. This is not the case when there are only two supports. Then a settling of one support makes no difference.

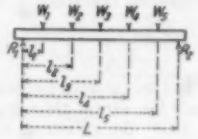

FIG. 7.

Again the calculation becomes comparatively difficult if, instead of dealing with a linear beam, we are dealing with a plate supported all round its edges, or at several places around its edges. Here again, a settling or displacement of one support may affect the calculations seriously. And glass, as we have seen, is most often supported in this way.

In the case of a bressumer supported by two reactions R_1 and R_2 (Fig. 7), loaded with one or more loads, equal or unequal, and spaced evenly or unevenly between the two supports, the maximum bending moment will come under one of the loads, W. Calculation or graphical methods may be used to determine which one.

The calculation proceeds in two steps, (1) the determination of the supporting reactions R_1 and R_2, and (2) the calculation of the BM under each load W.

The BM vanishes above R_1 and R_2, since beyond the supports there are no loads and no bending moments. The counterclockwise moment around R_1 is R_2L. The clockwise moment is $W_1l_1 + W_2l_2 + W_3l_3 + W_4l_4 + W_5l_5$. These must be equal to make the net moment at R_1 vanish. Hence R_2 can be calculated by equating these two expressions.

R_1 can then be found from the expression $R_1 = (W_1 + W_2 + W_3 + W_4 + W_5) - R_2$.

At any other point, say under a load like W_3, the bending moment can be ascertained by determining the counterclockwise moment of all the forces to the right of it, or the clockwise moment of all the forces to the left of it. The two are equal, of course.

Using the second method, for the point at W_2 we find that $BM = R_1 l_3 - W_1(l_3 - l_1) - W_2(l_3 - l_2)$; or using the first method ($BM = R_2(L - l_3) - W_3(l_5 - l_3) - W_4(l_4 - l_3)$.

These generalized equations are not ordinarily of interest to the glass man. There are two or three special cases of interest as follows:

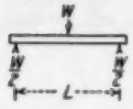

FIG. 8.

(*A*) A bressumer, supported at two points and loaded centrally. The maximum BM occurs under the load.

$$\text{Bending moment} = \frac{W}{2} \cdot \frac{l}{2} \text{ or } \frac{Wl}{4} \qquad (14)$$

(*B*) The load is spread uniformly over the surface like snow or wind. The two reactions are equal, and the greatest BM comes at the center. The load per inch of span is W/L.

At any point, P, distant x from the left-hand support the BM is $\frac{W}{2}x - \left(\frac{W}{L}x\right)\frac{x}{2}$, the first term representing the clockwise moment of the left-hand support, and the second term the counterclockwise moment of that part of the distributed load $\left(\frac{W}{L} \cdot x\right)$ to the left of P, which acts at an average leverage of $x/2$. Thus the BM is $\frac{W}{2}\left(x - \frac{x^2}{L}\right)$. This is zero at $x = 0$ and $x = L$, and is a maximum when $x = L/2$ or at the center of the span. Its value is then

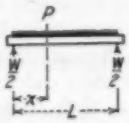

FIG. 9.

$$\frac{W}{2}\left(\frac{L}{2} - \frac{L^2}{4L}\right) \text{ or } \frac{WL}{8} \qquad (15)$$

That is, a distributed load of snow produces half the bending moment and therefore half the stress that is produced by an equal concentrated load such as is used in testing.

(*C*) As an exercise, and a case occasionally encountered, let us suppose an aquarium is built with a front of sheet glass held in place by girders at top and bottom (Fig. 10) giving reactions R_1 and R_2 per inch of horizontal length. Let the water level be just up to R_1 for simplicity's sake.

The pressure of the water increases with depth, being zero opposite R_1 and being ρH pounds weight per square inch opposite R_2, ρ being the density of the water (fresh or salt) in pounds weight per cubic inch.

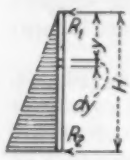

FIG. 10.

At any point, P, distant y_1 inches below R_1 the water pressure is ρy_1 and the load or force exerted per inch of horizontal length on the element dy is $\rho y_1 dy$. The total load on the whole vertical section having one inch of horizontal length is obviously

$$\underset{\text{(av. pressure)}}{\rho H/2} \times \underset{\text{(total light)}}{H} = \rho H^2/2$$

The center of pressure is equally obviously at $y = 2H/3$

Therefore $R_2 = 2R_1$ and since $R_1 + R_2 = \rho H^2/2$, $R_1 = \rho H^2/6$ and $R_2 = \rho H^2/3$

The bending moment at any point P is

$$R_1 y_1 - \int_0^{y_1} \rho y(y_1 - y)dy = R_1 y_1 - \rho[y_1 y^2/2 - y^3/3]_0^{y_1}$$

$$= R_1 y_1 - \rho y_1^3/6$$

$$= \frac{\rho y_1}{6}(H^2 - y_1^2)$$

This reaches its maximum at $y = \frac{\sqrt{3}}{3} \cdot H$ or $0.58H$ where its value is $M = \rho\frac{\sqrt{3}}{27} \cdot H^3$ per inch of horizontal length of glass.

As fresh water weighs 0.036 pound per cubic inch, the value of M is $M = 0.00234\,H^3$, where M is in inch-pounds per inch of horizontal length of the aquarium face and H is in inches.

(*D*) Occasionally other problems arise, but most bending moments are of the type figured on in cases *A* and *B*.

(*E*) An example of the stress developed is as follows:

Let the glass in the aquarium front be d inches thick. Then the section modulus Z is given by $Z = bd^2/6$; but b is taken as one inch of horizontal length, and then $Z = d^2/6$.

The stress developed is $M/Z = 0.014\ H^2/d^2$.

Let H be 100 inches (a little over eight feet, which is a good deep aquarium).

Then $f_s = M/Z = 14{,}000/d^2$.

If we decide that glass should be capable of standing 3500 pounds per square inch indefinitely, the minimum thickness of the glass should be 2 inches.

IX. Effect of End Supports

The glass of an aquarium is necessarily supported not merely at the bottom (and in general at the top) but also at the ends. In an aquarium as deep as 8 feet, the chances are that the glass would be supported by vertical stanchions at horizontal distances of less than eight feet. When this is the case the pressure of the water will be largely taken by the stanchions, and the bending moment will be greatly reduced.

The same thing is true of windows generally.

A window of flat glass supported all round must be somewhat stronger than it would be if supported only along its longer sides. It is stronger if supported on its longer sides (with a short span) than if supported on its shorter sides (with a long span). It is stronger still if supported on all four sides, provided it gets a good bearing on them all and is not warped or distorted to fit it in.

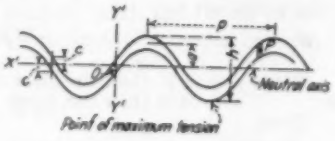

FIG. 11.

NOTE: This is not true of corrugated structural glass, with the corrugations running lengthwise of the pane, as is usual. We are dealing here with flat glass.

The amount of support contributed by the ends depends on the shape of the rectangle of the pane of glass. If the rectangle be long and narrow, the support given by the ends is virtually negligible, and the strength should be figured as if the ends were nonexistent. When the form approaches a square, the support is by no means to be despised. We shall give a few comments on that later.

X. Corrugated Structural Glass

Flat glass is necessarily called upon to withstand loads of some sort: as a store front it must withstand wind pressures; as a skylight it must withstand snow loads; as a show case shelf it must support a variety of distributed or concentrated loads. But it is not a structural form. It is one of the most inefficient forms for structural purpose, in fact the most inefficient of all possible forms.

The first definitely structural form is probably the corrugated rolled glass imitating in a general way the form and properties of corrugated sheet metal. The actual form of the present standard section of corrugated glass is shown in Fig. 11.

The moment of inertia may be computed by graphical methods, and the section modulus deduced from it. Or the outline of the curve may be assumed to be a true sine curve (it is quite close thereto) and the moment of inertia calculated directly.

The upper face of the glass as seen in the cross-section would then be expressible as a curve

$$y = a \sin \frac{2\pi}{p} x + c$$

and the lower face,

$$y = a \sin \frac{2\pi}{p} x - c$$

Where p = pitch of the corrugations (2.528 in.)
c = half thickness of glass measured vertically at any place (c = about $^5/_{16}$ in.)
a = "amplitude" or half the depth of the corrugation (a = about $^5/_{16}$ in.)

The element of inertia contributed by the blackened area at P, whose area is $dxdy$, is given by $I = y^2dxdy$, and the total moment of inertia for a sheet of glass b inches wide (provided b corresponds to an exact multiple of the pitch p, which is sensibly the case in practice) is

$$I = \int_{x=0}^{x=b} \int_{y=a \sin \frac{2\pi}{p} x - c}^{y=a \sin \frac{2\pi}{p} x + c} y^2 dydx$$

This works out to

$$I = bc(a^2 + 2c^2/3)$$

Write $c = t/2$ (half the glass thickness)
$a = d/2$ (half the depth of the corrugation)
Then

$$I = \frac{bt}{12}(3d^2/2 + t^2)$$

The numerical value of this for a standard pane in which $b = 27^3/_4$ in., $d = 0.72$ in., $t = 0.372$ in. is $I = 0.79$ inch^4 units.

This agrees well with the value determined experimentally.

The value of Z can now be calculated since $Z = I \div$ half total depth h or

$$I = \frac{bt}{6} \cdot \frac{3d^2/2 + t^2}{d + t}$$

XI. Deflection of Corrugated Structural Glass under Load

As we have seen, the deflection, using our usual nomenclature and assuming the load to be distributed, is $\delta = \frac{5}{384} \cdot \frac{Wl^3}{EI}$.

When compared with flat glass of the same span under the same load, the only difference is in the value of I. For flat glass of equal thickness and width I would be 0.119 inch^4 units, so that the corrugated form is, weight for weight, about six or seven times as rigid as flat glass. That is, it will deflect under a given load only about $^1/_6$ as much as flat glass.

XII. Comparison of Strength of Flat and Corrugated Glass

The strength of the glass may be calculated by the formulas dealt with earlier in this paper, and it will be found that the corrugated form should carry rather more than twice the load of a comparable piece of flat glass. This, however, includes the weight of the glass itself, and the useful load is

considerably more than twice as great. The calculation, however, assumes that the flat glass is supported like the corrugated glass, at the ends only, whereas the flat glass is supported all around, or is intended to be.

XIII. Strength of Triplex Glass

Laminated glass, consisting of two outer plates of glass ensandwiching a layer of celluloid or similar material, and commonly known by the trade name of Triplex, is structurally akin to an I-beam. The low value of Young's modulus for the celluloid makes this layer unable to carry its appropriate share of the direct stresses, in much the same way as the web of an I-beam is rendered incompetent by the narrowness of the web in comparison with the breadth of the flanges. And similarly to the I-beam, the web or celluloid must carry a shear load if it will not take the direct stresses.

We shall not here analyze the stresses in detail.

XIV. Sudden Loads

A snow load is a dead weight, but a wind load may be applied in gusts. A suddenly applied load will deflect a beam twice as far and develop stresses twice as great as a load that is eased on gradually. By a suddenly applied load is not meant an impact, the actual dropping of a load from a distance. But the load is to be brought into contact with the beam in its undeflected position and then released. It will deflect the beam beyond its equilibrium position, and set up vibrations.

XV. Pressure Due to Wind

The pressure exerted by a wind blowing normally (perpendicularly) against a flat plate varies with the square of the wind velocity, subject to minor corrections.

The full aerodynamic formula is of the form

$$R/S = \rho V^2 \varphi\left(\frac{VL}{\nu}\right) \psi \left(\frac{v}{V}\right)$$

Where R/S = pressure/sq. in. exposed surface
ρ = density of the air
V = velocity of the wind
φ and ψ mean "functions of"
L = some linear dimension of the test surface
v = velocity of sound in air
ν = kinematic viscosity of air (its viscosity as ordinarily defined divided by its density)

At such velocities of wind as glass normally encounters, except possibly in windshields of racing airplanes, the two functions are replaceable, to all intents and purposes, by constants.

The pressure then becomes $R/S = K\rho V^2$ or if the density of the air is taken as constant $R/S = k_2 V^2$.

Necessarily, if we make all these simplifications, some slight error may attach to the value we give to k_2.

"Standard" air density is, in aeronautical practice, 0.07651 pound per cubic foot.

The equation then reduces to p (lb./ft.^{2}) $= 0.003 V^2$ (miles/hr.).

When the wind blows in gusts the effective pressures may be twice as great due to the suddenly applied load.

In using the formula, convert the value of p into pounds per square *inch* before calculating any stresses.

The wind does not always blow squarely against the windows in a house but the windows must be designed to meet the square wind. In ordinary automobiles, the windshields are sensibly square to the "relative wind" at high car speeds. In airplanes the windows are sloped backward at the top, and the wind from the motion or the slip-stream from the propeller is incident on the windshield at an inclination to the perpendicular.

In Fig. 12A let the pane have a breadth, b, perpendicular to the paper. The amount of wind hitting it per second is $\rho \cdot v \cdot l \cdot b$, where ρ is density of air, and v, wind velocity. The momentum of this wind $\rho v^2 lb$ is completely destroyed by the impact, so far as its forward direction is concerned, and the pressure developed is measured by the momentum destroyed per second per unit area or $p = \rho v^2$.

In Fig. 12B, we have sloped the pane, and the amount of wind hitting it is only $\rho v l \cos\theta b = M$(say). The momentum is not wholly destroyed, but only that component of the momentum that is perpendicular to the glass, *viz.*, $Mv \cos\theta$.

FIG. 12A

The pressure developed perpendicular to the pane is then $Mv \cos\theta / lb = \rho v^2 \cos^2\theta$ or $\cos^2\theta$ times what we should get with the wind incident normally. Sloping the pane at 45° reduces the pressure to one-half (since $\cos^2 45 = {}^1/_2$).

FIG. 12B.

XVI. Impact Loads

When the load is dropped from a considerable distance instead of being merely suddenly applied, the glass is deflected still more extravagantly in proportion to the mere weight of the dropped load.

It is then necessary to calculate the stresses developed by the following device:

The glass is supposed not to break, but to bring the projectile to rest. In doing that, the glass is deflected or bent slightly. When bent it contains a certain amount of strain energy, and at the moment the forward movement of the projectile is just arrested, the strain energy of the glass is equal to the kinetic energy of the projectile.

The glass is supposed to bend just as it would under a static load, and then the energy stored in it is readily calculable (it can be calculated in terms of the dimensions of the beam and of the maximum stress developed). The kinetic energy of the projectile or dropped load is Wh, where W is the weight of the load and h is the height from which it is dropped. Equating the two gives a means of calculating the maximum stress set up by the impact, *viz.*, $f_{max} = \sqrt{\left(\frac{18E \cdot W \cdot h}{b \cdot d \cdot l}\right)}$ where E is Young's modulus, and b, breadth, d, depth, and l, span of beam.[1] This stress can apparently be a little higher than the stress developed by static loading, without the glass breaking, perhaps 20 to 40% greater.

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[1] F. W. Preston, "Impact Modulus of Glass," *Jour. Amer. Ceram. Soc.*, **14** [6], 428 (1931).

XVII. Vibrations

If the glass does not break on the downward flexing under the impact load, it will rebound and flex the opposite way. If the other surface be weaker than the lower, it may break on this rebound. Such cases are often observed.

XVIII. Built In Beams

When beams are not merely supported at the ends, but built in or attached in some way to a rigid support that prevents their tilting, they are theoretically stronger than if simply supported. Glass in its sash is more or less "built in," but it is believed that the rigidity conferred by typical glazing methods is not worth considering. On the contrary, such rigidity should probably not be aimed at, as it is likely to cause local pinchings and distortions that do more harm than good. A soft seat is to be desired.

XIX. Methods of Failure

A tensile fracture, and that is the only kind we meet, must be propagated through the glass (or other material). In other words it must have a point of origin, and from this it travels, either as a single crack or a forking one, to other places until the stresses are thoroughly relieved. Slow traveling fractures do not fork, and the fractured surfaces are very smooth. Slightly faster traveling produces ripple marks on the fracture surface. These ripples mark the temporary position of the fracture-front as it advances in little surges. If the travel becomes violent, it becomes unstable, just as waves at sea become unstable and develop whitecaps. The whitecaps in the glass leave a rough "hackly" texture in place of a mirror-like smoothness, and when this hackly texture becomes pronounced, the fissure is apt to fork into several fissures, or many hundreds. The mechanism has been traced in some detail in the writer's papers in the *Journal of the American Ceramic Society* and elsewhere.

It follows from the above that there are certain general laws applicable to the understanding of fractures; a smooth fracture is a gentle one. It implies a weak material or one lacking in homogeneity. A rough one, or a much forked one, implies a greater tensile strength. The position of the origin can usually be ascertained and is often significant.

In the testing of laths, by cross-bending or impact, the fracture may originate either at an arris or on the face. The arris fracture is usual if the diamond cut (used to cut the lath from a sheet) is on the tension side.

With corrugated glass, the fracture can not readily propagate, as it must pass from a tension zone through a compression zone before it can reach another tension zone. The fractures are accordingly of an elaborate and beautiful form, likened by some observers to the wings of birds or angels, though the manufacturer can rarely see anything angelic about a fracture. Each corrugation must, in general, originate its own fracture at the bottom of a trough in the corrugations, and this fracture spreads toward the two neighboring ridge-tops as a symmetrical pair of wings, turning from the normal to the horizontal aspect, and striated like a set of feathers, in its progress.

In the case of glasses supported all round, as in most window panes, there is little or no bending moment at the edges and the fracture should theoretically originate right in the center of the pane. As a matter of fact,

however, the bending moment is substantially uniform over a considerable area near the center of the pane, and therefore the fracture may originate at some distance from the center. The stress seems also to be (in the case of square panes) substantially isotropic, so that the original fissure may open in a direction parallel to one edge, or diagonally, or in any intermediate direction.

In all such cases (panes tested by air pressure) the fissure forks and forks again. The initial forking is usually into three fissures, inclined at 60° to each other, and this process is repeated as the fractures travel.

XX. Strength of Window Panes of Flat Glass

The calculation of the strength of "slabs" supported on all four sides is a little complicated. But it may be taken as a safe rule that a square pane of glass supported on all four edges is twice as strong as if supported on only two edges.

The pressure is usually an evenly distributed load, a wind load or a snow load of p pounds per square inch.

Let the square pane be l inches long on each side.

Then the total load to be carried is $pl^2 = W$.

If the glass be supported on two sides only, it becomes a simple bressumer, and if its thickness be d inches, its "section of modulus" is $ld^2/6$, and the bending moment is $Wl/8$.

The stress developed $= Wl/8 \div ld^2/6$ or $f_{max} = \frac{3}{4} \cdot \frac{W}{d^2}$. That is, any square glass pane (of a given thickness d) will carry the same total load, W, whatever the size of the pane.

The wind pressure or snow load it can carry, measured in pounds per square inch, instead of as a total load, of course increases rapidly with diminishing size since $W = pl^2$.

In the case of a square pane supported "all round," that is on all four edges, the maximum stress is only about half as great and we may write $f_{max} = \frac{3}{8} \cdot \frac{W}{d^2}$ or $f_{max} = \frac{3}{8} \frac{pl^2}{d^2}$.

If the pane be rectangular, having sides a and b, then to a first approximation $f_{max} = \frac{3}{16} \frac{p(a^2 + b^2)}{d^2}$.

In the case of wind pressures, p varies as the square of the wind velocity, in fact, $p = 0.003\ V^2/144$ (when V is in miles per hour wind speed and p is in pounds per square inch pressure).

Hence $f_{max} = \frac{0.009}{16 \times 144} \cdot \frac{a^2 + b^2}{d^2} \cdot V^2 = 0.009 \frac{D^2 \cdot V^2}{(48d)^2}$, where D is the length of the diagonal of the pane.

It is thus possible to calculate the wind velocity that a pane can safely support. If we take f_{max} as 4000 pounds per square inch (which most glasses will stand readily enough) then

$$V^2 = \frac{4000 \cdot 48^2 \cdot d^2}{0.009 \cdot D^2} \qquad \text{or} \qquad V = 32{,}000\ d/D$$

On this basis, to stand a hurricane of 100 miles per hour, the diagonal of a window pane should not exceed about 300 times the glass thickness; "single strength" window glass, $^1/_{16}$ inch thick, should not be used in panes with a diagonal greater than about 20 inches. A pane 12 by 16 inches would fall within this specification.

XXI. Effect of Poor Annealing or Disannealing

Since a tensile fracture must originate at a point, and does not originate simultaneously throughout a whole cross-section, it is possible to reinforce

the glass against failure to some considerable extent by placing likely points of origin under initial compressive stress. This is usually accomplished by thermal treatment, and may be called toughening, disannealing, or other names.

From time to time one hears remarkable stories of the behavior of pieces of glassware that were not intentionally disannealed, but were accidentally in that condition, and gave phenomenal service. For instance there was an account in the newspapers a few months ago of an old fashioned glass gas-mantle "chimney" in the far west that had been in use some twenty years. It had shown no signs of cracking, though a glass "chimney" does not normally last many weeks. The gas or the mantle hits it and it cracks from an overdose of heat. But this one did not. Then suddenly, after a life that bade fair to be everlasting, and with no provocation whatever, the chimney appeared to tire of life and committed suicide, going to pieces from no observable cause.

This is a not uncommon end of severely disannealed glass articles. I have myself kept plates of disannealed glass in the laboratory for weeks and then suddenly they would go to pieces when no one was near them, no vibration or temperature change was observable, and no reason could be assigned for the breakage.

Other people have reported bottles going to pieces on the shelves, tumblers collapsing on the dinner table, and so on. More common is the experience of glass manufacturers who find that the bottles which come safely through the leer, stand a thermal shock test perfectly well, and then crack during overnight storage; or of plate glass makers, who get the glass through the leer, finding that it will cut safely, only to break in the storage racks.

An attempt to develop a theory of the strength of strained glass was made by J. T. Littleton and the present writer a few years ago,[2] and the conclusion was then reached that thermal treatment could hardly be expected to increase the strength of glass to more than two or three times its normal value. The theory is probably wrong, or at least incomplete and imperfect, but in practice the figures cited do not appear to be amiss.

Although toughened glass is, if over-toughened, a somewhat treacherous material, it does not follow that we should stand firmly for perfect annealing. There is definitely an added strength to be obtained in most cases from imperfect annealing, if it be done intelligently, and there is no more reason for not utilizing this added strength than there is for abandoning the use of glass altogether on the ground that it is a nasty material in any case when it *does* break.

Window glass drawn by the Fourcault process is, apparently, always badly annealed. But it is annealed well enough to cut to size under the diamond. And when used as window panes, supported all round, it is probably all the stronger by reason of its imperfect annealing. For this throws the surfaces of the sheet into initial compression, and the glass has to be bent appreciably more before the tension developed by the bending becomes critical.

This strength is, however, illusory if the glass be not of an excellent flatness. A slightly curved or crenelated or wavy piece of drawn glass is apt to be weaker rather than stronger if disannealed.

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[2] *Jour Soc. Glass Tech.*, 13, 336 (1929).

Moreover, the glass can not well be ground and polished if made by the Fourcault process. For on grinding off one side, one grinds away a layer of compressed glass and the stresses inside are redistributed. The glass wants to become concave on its upper surface. The corners of a sheet come up into the air and get broken by the grinding machinery. Very soon there is a pile of cullet. The Fourcault leer is too short for annealing glass that is to be ground and polished. The Colburn process (Libbey-Owens method), on the other hand, uses a longer leer and gives entirely satisfactory results.

To return to lamp chimneys: the thinner the glass, in general, the stronger the chimney for its purpose, for chimneys do not usually break from rough handling but from overheating in spots. If the glass be thin, it is difficult to establish a great temperature difference between inside and out. The stress developed depends solely on the total difference of temperature between the inside and the outside, and not on the temperature *gradient*, which may be just as steep in a thin glass as in a thick one, or steeper.

Thinness therefore is desirable, but there is a limit to thinness of a practical sort, for a modicum of mechanical strength must be given to any glass structure. Therefore we are still in danger from the heat, even if we use the thinnest glass possible. Accordingly we turn the wick, or the gas, low at first, till the glass warms through, and only then do we set the outfit to give a good light.

The heat is inside the chimney, and the inner face of the chimney gets hotter than the outside. In consequence the outer face is thrown into tension. Such a structure will be the stronger if, by disannealing, the outer face is given an initial compression. For similar reasons it may be wise to develop a compression at the ends of the chimney, as cracks like to begin at an arris.

While we are dealing with the thickness of glassware to resist thermal shock, we ought to mention Gould and Hampton's demonstration that in beakers and similar chemical ware the "thermal resistance" is approximately inversely proportional to the square root of the thickness of the article.[3]

XXII. Strength of Tubes

Glass is used a great deal in the form of tubes. The gasoline cylinders used for dispensing petrol at wayside stations to the ever-thirsty automobile are examples of large tubes. They are also tubes wherein the bore of the glass is large and the wall-thickness small. The strength of such cylinders may be calculated by the simplified theory of "*thin*" *tubes*. At the other extreme comes thermometer tubing, where the article itself is small and the bore very small in comparison with the wall thickness.

The ordinary mercury-vacuum thermometer does not develop any internal pressure unless the thing is savagely overheated and the mercury fills the whole of the vacuum space. But in the high-temperature forms, wherein the space above the mercury is filled with nitrogen, a considerable pressure may be developed. The strength of such articles would have to be worked out by the more complex theory of "*thick*" *tubes*, were it not for the

[3] *Jour. Soc. Glass Tech.*, **14**, 190 (1930).

fact that the thing that gives way is the thermometer *bulb*, not the stem, and the bulb does not have the same proportion of wall thickness to bore.

The gage glasses that give the water level on steam boilers or on some ammonia-distillation plants are of a wall thickness sufficient to warrant the application of the theory of thick tubes. With the rapid increase in the pressures used in industrial processes, steam boiler practice, and elsewhere, it may become important to look into these matters.

The ordinary bottle, typically circular in section, is a tube closed at one end, the base, and drawn down to a neck at the other. The glass jar is similar, except that the neck is much less conspicuous, and in some instances the tube may be regarded as more or less open at one end, and at others as being more or less closed at both ends. Milk bottles are half way between jars and proper bottles.

The walls of bottles are usually thin enough for the application of the theory of *thin* tubes. This has been done by the present writer.[4] This relates essentially to the stresses developed by hydrostatic internal pressure. Such pressure may arise from steam, from carbonated water, from thermal expansion of the liquid till it fills the whole bottle, from expansion of the liquid on freezing, or otherwise.

Hydrostatic internal pressure develops tensions in the containing walls. These tensions are greater on the inner face than on the outer face of the tube. The difference is insignificant (and is ignored) in thin-walled tubes, but is very important with thick walls.

Poor annealing of tubes produces tension on the inner faces. Thus poor annealing is detrimental to structures intended to carry internal hydrostatic loads. This statement, however, requires modification in practice in a great many instances. The outer faces of a tube are more apt to get scratched or bruised than the inner faces, and this weakens them in comparison. It may therefore pay not to overdo the annealing. Again in steam boiler gage glasses, water at 300°F or more may be in contact with the inner face, while cold air is blowing on the outer face. This temperature difference may be more important than the tensions arising from the hydrostatic pressure, and again calls for poor annealing of the gage glasses (which they generally get).

Bottles form so large a proportion of the output of the glass industry, that we may be pardoned for recurring to them once more. A great complication is introduced in the bottle, considered as a tube, by the presence of the bottom of the bottle. This bottom is usually thicker than the sides, cools later than the sides, and as a result is more or less like a thick drum skin stretched across the end of the bottle. The inner face of the base cools last, and is more stretched than the outer face, but in some cases it seems that even the outer face can be in tension. This is not good, and the base is accordingly a sort of Achilles' heel for the bottle. The benefits that might accrue to the bottle user if the bottle were more disannealed than it usually is, are rendered virtually inaccessible by the difficulty the manufacturer experiences in taking proper care of the base. The subject is too complicated to be dealt with fully here.

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[4] F. W. Preston, "Form of Cracks in Bottles," *Jour. Amer. Ceram. Soc.*, 15 [3], 171 (1932).

XXIII. Strength of Globes and Bulbs

Steel is rarely worked up into hollow spherical shells. There are, however, "egg-ended" boilers (cylindrical boilers with hemispherical ends riveted on), so that the steel man has paid some attention to the strength of spheres. In masonry, too, the dome is an important structure, and its stability is of great importance. Otherwise St. Peter's at Rome, St. Paul's in London, and the Capitol at Washington (not to mention all the small fry in the way of state capitols) might collapse and leave us without either church or state. Accordingly the theory of the dome, like that of its two-dimensional counterpart, the "arch," has come in for a good deal of attention. But the theory is very complicated.

Glass is so easily blown into spherical shapes, even "off-hand" (*i.e.*, without using any mold to contain it), that spherical glass articles are among the commonest. Gilt and silver spheres of the frailest glass from the forests of the Rhine bedeck the Christmas trees of all civilization; and David Gray's "399" (the Corning bulb machine) tosses out four hundred bulbs a minute, of rather more robust proportions, to lighten the darkness of a bewildered world.

Not all Christmas tree bulbs are spherical, and electric lamp bulbs must necessarily have a stalk at one end, but they generally contain one straightforward hemisphere.

The strength of a sphere or dome is remarkable. Every one who has tried to break a hen's egg in lengthwise compression between the hands knows that. And in the absence of small boys with catapults, the electric works inside a street lamp bulb always collapse before the glass bulb.

With the gigantic lamp bulbs in use lately for airport flood-lights and housing filaments that consume many kilowatts, the question of adequate strength at times become important. The lamps are gas-filled, and in operation the gas develops a pressure beyond atmospheric. Let the excess above atmospheric be p pounds per square inch. Let the diameter of the bulb be D and the wall thickness t. Then on a diametral plane we have a gas pressure exerting a total force of $\pi D^2 p/4$ and a wall of area πDt square inches to withstand it. The tension developed is, accordingly, $\frac{\pi D^2 p}{4} \Big/ \pi Dt = \frac{Dp}{4t}$. If a bulb $6^1/_2$ inches in diameter has a wall thickness of 0.035 inch, and the excess pressure developed is one atmosphere (14 lb./sq. in.), the tension in the glass is 650 pounds per square inch.

When the lamp is turned off, the pressure falls below atmospheric and the glass is then in compression. In a perfect sphere, such stresses could be borne even if they were of gigantic proportions, but the bulb is not a complete sphere, and bending stresses are set up. These are more serious, but as they are so complicated, we shall not endeavor to map them out here.

XXIV. Crushing of Glass

This brings us back once more to a consideration of the compressive strength of glass. Tests are made from time to time on the compressive strength of glass and yet, we fear, there is not, in the minds of most experimenters, any idea as to what is meant by the compressive strength of glass.

Glass may *be* in compression in use; it may be *tested* under compressive stresses; but it will not *fail* under compressive stresses. If it breaks, it

will break by reason of tensile stresses developed as a secondary consequence of the compressive ones.

XXV. Strength of Struts

A strut is a rod under endwise compression. If the strut is fairly long, then according to the ideas of engineers, when failure occurs, it will be caused by the strut "buckling," that is, the strut will not crush down, but will bow sideways. The bending stresses developed by this flexure soon overshadow the stresses due to the direct compressive load, and the consequence is that such a point as P on the outer surface of the bow is in tension, and not in compression at all. The specimen then fails (in the case of a glass rod) by cracking from this side of the bow.

Let A = cross-sectional area of rod
Z = "section modulus"
F = endwise load
x = displacement of rod from initial straight position.
Then, direct compression = F/A.
Bending moment at center of length = Fx.
Bending stress at $P = Fx/Z$ (and is a tension).
The total or net tension at $P = Fx/Z - F/A$ or $F\left(\frac{x}{Z} - \frac{1}{A}\right)$

When x gets big enough, *i.e.*, as the strut bows more and more under increasing load, a point is reached at which the net tension is more than the rod will bear. It then fails *in tension*, though it is nominally being tested in compression.

The formula as given is not easily used because, although F, Z, and A are known, we do not at first sight know x. We have, however, spoken of x increasing under increasing load, but it may happen that the bow will increase under constant load. There is, in fact, a particular or critical load which will *hold* the rod bent if it is *once* bent. Under lower loads, the rod will straighten itself. Under a greater load the bow will go on increasing, and the increasing values of x, increasing the bending stresses, will break the rod.

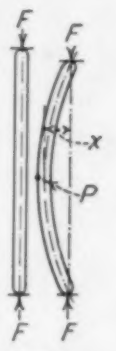

FIG. 13.

The theory (Euler's theory of struts) is given in the textbooks.

(1) Short Struts The way to prevent a strut collapsing by buckling is to give it a high enough value of Z, the section modulus. This means, in general, making the strut moderately wide in proportion to its length. This is the reason why the booms of cranes are made of a bellied lattice-work construction, instead of being a single piece of cold-rolled shafting with the same cross-sectional area and weight. And this is one reason why the gaunt pylons supporting high tension wires in their swinging stride across the landscape are made of an open trellis work in column form instead of being a simple circular shaft like an enlarged telegraph pole.

Accordingly, in making a compression test of a material, it is usual to shorten the strut and increase its diameter till it is nothing but a chunk. It may be a cube. Perhaps it is better when it is a cylinder, with the diameter approximately equal to its length. Such a specimen can hardly be accused of a disposition to bend, and thus set up tensile stresses.

But tensile stresses are none the less set up in various ways and if the test succeeds in going to destruction, it is because of these tensions. For instance, Dr. Littleton reported a case where he carried out such compression tests on cylinders about $^1/_2$ inch diameter by $^5/_8$ inch long. They stood all the load he could put on them with a hydraulic machine, but they broke when he tried to take the load off.

The reason was that the glass was being tested between hard steel plates and these plates did not expand sideways as fast as the glass expanded sideways under the longitudinal compression. The glass slipped outward a little at the interface, the friction not being enough to hold it. This operation did not hurt the glass, for in such slipping it was compressed radially. But when the load was taken off, the glass had to *contract*

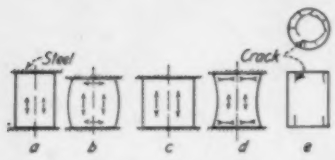

FIG. 14.—In *a* the compression is just beginning; the little vertical arrows show vertical compression throughout the body of the glass. At *b* the compression has increased and the glass is bellied out, producing a general horizontal compression in the layers of glass near the steel. At *c* slipping has occurred, and the horizontal compressions have been largely relieved. At *d* we are starting to remove the load, and the glass is bellied inward at the waist, leaving the layers next the steel in drumskin tension. As the steel bites a bit harder at the edge of the glass, the inner part of the contact circle tends to pull away from the rim, making a more or less circular crack as shown at *e*. As the tension is of a drumskin or isotropic variety, radial cracks also form as indicated.

sideways more than the steel end-plates. This threw it into tension, and cracks ran *vertically* down the glass, parallel to the axis.

The attempts to break glass in compression always result in failure to break it at all, or else in breaking it in tension. A frequent cause of failure is by getting a load on one edge, and spalling off chips as in a chipped palaeolithic flint arrow head. Our prehistoric ancestors in Europe, and our contemporary Australian natives (and nearly contemporary redskins) were expert at developing *tensions* in the flint as a consequence of applied *pressures*.

From what has been said above, it will be clear that the term "compressive strength of glass" is a rather meaningless term. Compression tests may be made under strictly defined conditions, but up to date those conditions have not been defined. The failure of the glass, when it occurs, will be due to minor tensile stresses developed incidentally (and so to speak, accidentally), and their amount depends in general, on rather subtle factors, and on things that are difficult to specify or control accurately. From a practical point of view, the compressive strength of glass may be almost anything. From a theoretical point of view it is infinite.

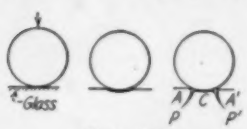

FIG. 15.

XXVI. Crushing Stresses

In ordinary practice, a structure receives its loads at particular points. A beam is bent by a load at the center, for instance, in a bending test. The stresses of most consequence are those produced by the bending, but in the immediate neighborhood of the load there is a complex concentration

of stresses known generically and loosely as the "bearing stresses." Bearing stresses also occur naturally at the supports or reaction points. They tend to crush or deform the structure at these points. For these reasons, in engineering practice, bearing plates, "sole-plates," or "pole-plates" are often used at such points as pads to spread the load.

Consider a hard sphere pressed downward on a plane glass surface. The glass, generally speaking, is compressed by the load, which is of the general nature of a pressure. But the glass may be divided into two zones. There is a zone directly under the ball which is unequivocally in compression, but there is also a zone AA^1 surrounding this which is deflected downward and wants to rise. It could rise if a conical crack PP^1 could open as in the third sketch. Hence across some such surface as PP^1 there must be a tension.

This tension arises, so to speak, indirectly from the pressures. It may be of relatively small amount, as compared with the direct compression at C, but when the glass breaks, it breaks under the tension, and a conical (or more nearly hyperboloidal) fracture opens as shown. On the surface of the glass this fracture outcrops as a small circle just outside the circle of contact between ball and plate.

Some important technical processes depend on utilizing tensions developed in this roundabout way. A sandblast will cut through a glass plate by the impact of little round sand grains which cause tensile flaws in this fashion. The grinding of plate glass, optical lenses, etc., is effected in the same manner. Granite is sawn through by pressing and rolling "chilled shot" on it under a blade of perfectly smooth steel. The blade is really a hammer, striking the spherical "shot" sudden little blows and so developing tension cracks under them.

FIG. 16.

The abrading of the granite features of the Sphinx by the sand of the Egyptian desert is done by the same action, little rounded grains by their impact producing little tensile fissures which ultimately loosen up the surface and cause it to spall off in minute fragments.

But what happens to the sphere itself? The sphere also is not free from tensile stresses. There is a more or less conical area, shown shaded, which is really under compression, and a surrounding zone T which is in tension.

By pressing a glass "marble" or "alley" between two hard steel plates, or preferably one hard steel and one soft, it is sometimes possible to spall off the tension zone neatly. The conditions in the sphere and plane are of course quite similar. They are particular cases of the more general one, studied mathematically by Herz, of pressing one sphere upon another, the spheres being of the same or different radii.

When one sphere is small and the other large, however, or when one is a grain and the other a massive plate, it is obvious that there is one important difference. The stresses in both are most severe near the contact, but whereas the stresses in the big plate die out rapidly as we go away from the contact, they die out much less rapidly in the grain, which has, so to speak, a very much smaller volume to "dilute" the stresses. This is particularly the case with small grains, for here, for reasons we shall not now discuss, the contact circle is relatively large in comparison with the size of the grain.

The consequence is that if grain and plate fracture simultaneously

the fracture is not propagated far in the plate, but in the grain the fracture mashes the thing to powder.

The experiment of grinding a piece of massive quartz with an abrasive of hard quartzite sand may be tried. The abrasive is ground to finest dust before any serious impression is made on the massive plate. The same thing is found in trying to grind a piece of glass with its own grit for abrasive. The damage done to the abrasive greatly exceeds that done to the massive piece.

Again, in grinding plate glass with silica sand, it takes several tons of sand to remove one ton of glass débris.

But none the less it remains true that the crushing of the sand, and the crushing of the glass are due alike, not to the compressions developed, but to the tensions incident thereto.

BUTLER, PENNSYLVANIA

THE USE OF SUCROSE IN SAND-LIME BRICK*

By W. A. Hamor,[1] Gerald J. Cox,[2] John Metschl,[3] and J. W. Van Brunt[4]

I. Introduction

In a previous paper by two of us,[5] that reviewed the nonfood uses of cane sugar (sucrose), a brief statement was made regarding an examination of the old use of sugar in lime-sand mortar. Our first investigation revealed that the addition to mortar of as little cane sugar as 6% of the CaO content of the lime, increased the tensile strength about 60%. The extension of this research, details of which will be published later on, has confirmed our observations respecting the value of sucrose in lime-sand mortar.

II. Preliminary Considerations Concerning Sugar, Lime, Silica, and Calcium Silicate Mixtures

Brief attention to the chemistry of sugar, lime, silica, and calcium silicate is essential to a clear understanding of the part that sugar plays in increasing the strength of sand-lime mortar and brick.

Sucrose solutions have an active solvent power for calcium hydroxide. In the cold solution a calcium monosaccharate is formed. The solubility of the lime decreases as the temperature is raised, a phenomenon rather general for calcium salts. Lamy[6] (p. 1144) states that the following amounts of calcium hydroxide (as CaO) are dissolved by 1000 grams of a 10% sugar solution. The solubilities of CaO in water at the same temperatures are given by Lamy.[6]

Temp. °C	0°	15°	30°	50°	70°	100°
CaO in sugar solution (grams)	25.0	21.5	12.0	5.3	2.3	1.55
CaO in water (grams)	1.4	1.3	1.17	0.96	0.79	0.60

As a solution of calcium monosaccharate is heated to temperatures near the boiling point, a precipitate of tricalcium saccharate is formed which redissolves on cooling. The reaction is represented by the equation

$$3C_{12}H_{22}O_{11}\cdot CaO \rightleftharpoons 2C_{12}H_{22}O_{11} + C_{12}H_{22}O_{11}\cdot 3CaO$$

In addition to the increased solubility of lime in sugar solutions, silicic acid and calcium silicate, according to Weisberg[6] (p. 1138), are dissolved to a slight extent by sucrose solutions. It is stated that 100 cubic centimeters of sugar solutions of 10 and 30% concentrations dissolve 0.0135 and 0.0157 gram, respectively, of precipitated, calcined calcium silicate at 17°C and 0.0195 and 0.0249 gram, respectively, at 100°C. Silicic acid is dissolved by 100 cubic centimeters of a 10% solution of sucrose to the extent of 0.0188 to 0.0268 gram at 100°C.

* Contribution from the Sugar Fellowship, Mellon Institute of Industrial Research, Pittsburgh, Pa., and Jackson and Church Co., Saginaw, Mich. Presented before the 28th Annual Convention of the Sand-Lime Brick Association, Detroit, Mich., Jan. 17, 1933. Received January 14, 1933.

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[3] Industrial Fellow, Mellon Institute.

[4] Vice-President, Jackson and Church Company.

[5] G. J. Cox and J. Metschl, *Ind. Eng. Chem.* [News Edition], **10**, 149 (1932).

[6] E. O. von Lippmann, Chemie der Zuckerarten, Vol. 2. 3rd ed. Braunschweig, 1904.

In sand-lime mortar and brick containing sugar the lime is greatly in excess of the sugar, which is therefore presumably all combined and may not affect the solubility of either sand or calcium silicate.

III. Sugar in Sand-Lime Brick

The sand-lime brick process involves the formation of a calcium silicate under the conditions of the temperature of steam at 100 pounds per square inch during a period of 8 to 10 hours.[7] Obviously, if more calcium or silicic acid is in solution, the rate of formation and the total amount of calcium silicate formed would be expected to be increased. If calcium silicate is more soluble in the presence of sugar, its deposition would be affected. The value of cane sugar in lime-sand mortar has suggested a similar use in sand-lime brick in spite of the known precipitation of calcium trisaccharate at elevated temperatures. At least, at 100°C more calcium is in solution in the presence of sugar than in water.

TABLE I

SIEVE ANALYSIS OF SAND

Sieve No. (Tyler series)	Per cent retained	Opening (in.)
28	1.91	0.0232
35	45.45	0.0164
48	43.50	0.0116
65	2.23	0.0082
100	2.92	0.0058
150	1.15	0.0041
200	1.69	0.0029
Passed all meshes	1.15	

IV. Experimental Work

A preliminary trial of the value of sucrose in sand-lime brick was made with the materials in current industrial use in a modern plant. Fifty pounds of sand (containing approximately 10% of water) were mixed with 3.5 pounds of hydrated lime. To half the mixture was added a solution of sugar equivalent to 6 grams per brick. The brick were pressed and cured overnight at 100 pounds steam pressure. It was then found that the average modulus of rupture of five brick had been thus increased from 291 to 442 pounds per square inch and the compressive strength from 1654 to 1978 pounds per square inch.

A second test differed from the first only in that the steam pressure was raised to 100 pounds as quickly as possible instead of allowing an initial heating for several hours at low pressure. The modulus of rupture was increased from 435 to 553 pounds per square inch, but the compressive strength decreased from 2041 to 1990. These experiments were sufficiently promising that it was decided to make further experiments, varying the concentration of sugar and ascertaining the value of other compounds.

The materials and methods were as follows:

(1) Sand The sand used was that generally employed in the Saginaw region; it was sifted through a 20-mesh sieve. Dried at

[7] For a full description of the practice followed in producing sand-lime brick, see W. E. Emley, "Manufacture and Properties of Sand-Lime Brick," Bur. Stand. *Tech. Paper*. No. 85.

110°C, it was found to contain 0.39% of moisture. A sieve analysis showed it to be composed as given in Table I.

(2) Lime High-calcium hydrated lime was screened to pass a 60-mesh sieve. Its composition is presented in Table II.

TABLE II

COMPOSITION OF LIME

	(%)		(%)
Silica	0.38	Phosphorus pentoxide	0.008
Iron oxide and alumina	0.16	Carbon dioxide	4.85
Calcium oxide	66.92	Moisture (105°C)	4.85
Magnesium oxide	1.05	Insoluble material	0.40
Sulfur trioxide	0.21	Loss on ignition, including CO_2	26.32

(3) Sugar and Other Addition Materials In most of the experiments ordinary granulated sugar (designated in Table IV as "sucrose") was used. Three commercial grades of soft sugar were employed, namely, Nos. 6, 9, and 15, which are referred to in Table IV by those numbers. One sample of a Cuban raw sugar and a beet molasses containing approximately 50% sugar were also tried. The glucose and dextrin that were used were the ordinary commercial products in dry form. Calcium acetate was employed as a representative non-carbohydrate salt.

(4) Mixing Twenty-five pounds of sand and 1.75 pounds of hydrated lime were weighed on a spring scale, thoroughly mixed, and then passed twice through a 20-mesh sieve. Water was added to give the proper consistency for pressing, varying from 300 to 400 cubic centimeters per batch. Additions of carbohydrates were made by dissolving the materials in part of the water. In cases of the larger quantities of sugar, a noticeable stickiness developed in the mixture.

(5) Pressing To insure uniformity in the size of the brick, 4.5 pounds of the sand-lime mixture were weighed accurately on a trip balance. The "green" brick were pressed at 10,000 to 12,000 pounds per square inch in a small rotary press and transferred immediately to the curing cylinder.

(6) Curing The brick were steamed overnight in a cylinder equipped with a recording pressure gage. A low pressure (15 lb.) preheating period was used for all brick, followed by a high pressure (100 lb.) curing period. The periods of curing are given in Table III.

TABLE III

CURING OF SAND-LIME BRICK

Expt. No. (inclusive)	Preheating 15 lb./sq. in. (hours)	Curing 100 lb./sq. in. (hours)
1–3	4.25	16
4–13	4.75	15.25
14–18	5.50	15

(7) Testing Transverse and crushing strengths of the brick were determined by the method given by Committee C3 of the American Society for Testing Materials.[8] Transverse strength is re-

[8] *Proc. A.S.T.M.*, **13**, 282 (1913).

ported as modulus of rupture obtained from the formula $M = \frac{3Wl}{2bd^2}$, in which

M = modulus of rupture
W = breaking load
l = distance between supports
b = breadth of brick in inches
d = depth of brick in inches at center

The half brick from the transverse test were used for determining compressive strength. The latter was calculated by means of the formula $S = \frac{Pa}{A}$, in which

S = compressive strength
P = gage pressure
a = area of ram
A = area of brick

Two lots of brick were also made, containing 6 grams of refined sugar and No. 15 sugar, respectively, for determining the absorption of water and for observing efflorescence.

For the absorption test, the brick were dried at 105°C, cooled, weighed,

TABLE IV

MODULUS OF RUPTURE AND COMPRESSIVE STRENGTH OF SAND-LIME BRICK CONTAINING SUGAR

	Substance Added		Av. modulus of rupture (lb./sq. in.)	Av. compressive strength (lb./sq. in.)
Expt. No.	Kind	Amt./brick* (grams)		
1	No addition	0	251	1680
2	Sucrose	2	300	1907
3	Sucrose	4	260	2089
4	No addition	0	269	1750
5	Sucrose	2	289	1750
6	Sucrose	4	329	1949
7	Sucrose	6	312	1550
8	Sucrose	10	357	1827
9	Sucrose	12	390	1763
10	Glucose	6	353	1699
11	No. 6 sugar	6	349	1846
12	Beet molasses	12	359	1910
13	Sucrose	6	372	2140
14	No. 9 sugar	6	317	1666
15	No. 15 sugar	6	355	1798
16	Raw sugar	6	359	1936
17	Dextrin	6	204	1231
18	Calcium acetate	6	286	1526

* As 4.5 lb. are approximately 2000 grams, the figures of this column apply directly as pounds of sugar per ton of brick.

placed on end, and covered with water at 25°C. After five hours the brick were removed, wiped with a cotton cloth, and weighed.

The efflorescence test was made by placing the brick on end in beakers with sufficient distilled water to moisten the brick completely. The brick were kept wet for ten days in a stream of air from a fan, and then examined for discoloration and any deposits due to leaching and evaporation.

V. Discussion of Results

The data of the strength tests are shown in Table IV. The brick of Experiments No. 1 and 4 comprise the controls. It is clearly evident from these data, and from those of the preliminary experiments, that the addition of sucrose increases the transverse strength of sand-lime brick and, to a less degree, the compressive strength. The maximum strength is reached by the inclusion of about 6 grams of sucrose per brick, or about 13 pounds of sugar per thousand of brick. No particular difference due to kind of sucrose is observable in these data, though more extensive trial might show disadvantages from substances occurring as impurities in raw sugars or molasses. Glucose is apparently effective, but dextrin lowers both the transverse and compressive strengths. Calcium acetate is without effect.

The brick containing 6 grams of refined sugar absorbed 13.83% of water; those containing No. 15 sugar, 13.36%.

No inorganic deposits were observed in the efflorescence test. A light brown stain was formed at the top of the brick. As no distinction could be made between the colors, this stain did not seem to be attributable to the original dark color of the No. 15 sugar. The discoloration may be caused by caramelization of the sugar or by humus material in the sand that has been rendered soluble by calcium saccharate.

ENAMELS OF STANDARD COLORS FOR VITREOUS CHINA SANITARY WARE AT CONE 6*

By Karl M. Kautz

ABSTRACT

The composition and preparation of the six colored enamels for producing the standard color samples in use in the sanitary ware industry are given. These enamels can also be used for the production of a standard vitreous china sanitary ware at cone 6.

I. Introduction

Due to the large number of colors in use in the sanitary ware industry, the manufacturers of sanitary ware encountered costly problems in attempting to manufacture, stock, or sell colored ware. Realizing the need for a standardization of colors, the sanitary-ware manufacturers, in coöperation with the Division of Trade Standards, chose six representative colors as standard. Those selected were as follows:

Standard color	
Green, No. 11	Blue, No. 40
Orchid, No. 20	Brown, No. 51
Ivory, No. 30	Black, No. 60

These colors became effective July 1, 1931, and are the specified standard for all manufactured articles used in the bathroom, for vitreous china, porcelain (all clay), enameled iron, metal, wood, or glass.

Colored ware to be known as standard must match or agree in color tone within certain limits of tolerance with the standard color. Comparison is made in light from the north sky with a standard median shade colored sample of vitreous china.

Note: Standard colored samples can be obtained from the Division of Trade Standards, Bureau of Standards. The compositions of all the enamels described here can also be obtained from the same source.

It is the purpose of this paper to deal more or less in detail with the composition, preparation, application, and firing of the colored enamels used in producing the standard median shade colored samples. These same enamels are also commercially practical for the production of standard colored vitreous china sanitary ware at cone 6. No attempt has been made to give any of the steps in the development of these enamels or the changes which have subsequently taken place.

Note: The term "enamel" is used here as meaning an opaque, glassy coating fused by heat on ware either of metallic or clay base in contradistinction to a glaze which may be similar in composition and physical properties, but which is not opaque.

II. Green Enamel, Standard Color No. 11

This standard color is light green with a distinct blue cast. The most dependable green colorants in enamels and glazes are the compounds of chromium and copper. Copper colors, however, are unreliable above cone 8. The color of this enamel is produced by a careful blend of two

* Presented at the Annual Meeting, American Ceramic Society, Pittsburgh, Pa., February, 1933 (White Wares Division). Received June 2, 1932.

colored stains, a green stain in which chromium compounds are the colorants and a blue stain in which cobalt compounds are the colorants.

(1) Composition and Preparation of Colored Stain The composition of the green stain (G 7) is as follows:

PERCENTAGE BATCH

	Per cent		Per cent
Potassium dichromate (pulverized)	35.0	Whiting	20.0
Plaster of Paris	12.5	Fluorspar	12.5
Flint	20.0		
			100.0

This batch is mixed thoroughly dry by hand, screened several times through a 40-mesh screen, and again mixed by hand. Calcined in closed saggers to cone 10, the sintered mass crushed, ground wet to pass a 200-mesh screen easily, washed free of soluble salts by repeated stirring with water, settled, and decanted. The mixture is then dried and pulverized for use.

The blue stain (BE 2) has the following oxide formula: $CoO{\cdot}4ZnO{\cdot}5(Al_2O_3\,2SiO_2\,2H_2O){\cdot}15SiO_2$.

PERCENTAGE BATCH

	Per cent
Cobalt oxide	3.0
Zinc oxide	12.5
English china clay	50.0
Flint	34.5
	100.0

The ingredients are weighed and ground wet in a ball mill to insure better mixing of the china clay with other ingredients. The slip produced is dried and the mass pulverized and calcined to cone 10, covered saggers being used as containers. After calcining, the sintered mass is crushed, ground wet to pass a 200-mesh screen easily, washed thoroughly, dried, and pulverized for use.

(2) Composition of Green Enamel The green enamel, exclusive of opacifier and colorants, has the following empirical formula:

$$\left.\begin{matrix}0.30\ Na_2O\\0.35\ CaO\\0.25\ PbO\\0.10\ BaO\end{matrix}\right\}0.40\ Al_2O_3\quad\left\{3.20\ SiO_2\right.$$

The percentage batch for this enamal (SC 11) is as follows:

	Per cent		Per cent	Add	Per cent
Soda feldspar	42.0	Whiting	9.4	Borax	2.0
English ball clay	6.9	White lead	17.2	Zirconium oxide	7.5
Flint	19.2	Barium carbonate	5.3	G 7 stain	3.0
				BE 2 stain	2.5
			100.0		

III. Orchid Enamel, Standard Color No. 20

This standard color is a light bluish pink and was chosen as the easiest of the pink group to produce uniformly at high temperatures. The pure pink colors are difficult to produce at cones 6 to 7 and are very unreli-

able. This color is produced by a chromium-tin oxide stain in a suitable glaze.

(1) Composition and Preparation of Orchid Stain The composition of the orchid stain (L 1) is as follows:

PERCENTAGE BATCH

	Per cent
Tin oxide	86.0
Borax	8.6
Potassium dichromate (pulverized)	5.4
	100.0

This batch is prepared by mixing dry by hand tin oxide, powdered borax, and pulverized potassium dichromate in correct proportions. It is screened several times through a 40-mesh screen and again mixed thoroughly by hand. It is calcined in covered saggers to cone 10; the sintered mass is crushed, ground wet to pass a 200-mesh screen easily, washed free of soluble salts, dried, and pulverized.

(2) Composition of Orchid Enamel The orchid enamel, exclusive of opacifiers and colorants, has the following empirical formula:

$$\left.\begin{matrix}0.20\ K_2O\\0.20\ CaO\\0.40\ PbO\\0.20\ ZnO\end{matrix}\right\}0.30\ Al_2O_3\left\{3.00\ SiO_2\right.$$

The percentage batch for this enamel is as follows:

	Per cent	Add	Per cent
Potash feldspar	30.0	Borax	2.0
English ball clay	6.9	Tin oxide	3.0
Flint	25.8	Zirconium oxide	3.0
Whiting	5.3	L 1 stain	5.0
White lead	27.7		
Zinc oxide (calcined)	4.3		
	100.0		

IV. Ivory Enamel, Standard Color No. 30

This standard color is a light yellow-brown color. There was not a great variation in the shades of ivory colors in use among the manufacturers of sanitary ware, the difference being largely of intensity rather than of hue. No prepared stain was used in the production of this color, as the commercial yellow sodium uranate ($Na_2O{\cdot}2UO_3{\cdot}6H_2O$) serves satisfactorily as the colorant when incorporated in an enamel of suitable chemical composition.

(1) Composition of Ivory Enamel The ivory enamel, exclusive of opacifier and colorant, has the following empirical formula:

$$\left.\begin{matrix}0.20\ K_2O\\0.20\ CaO\\0.40\ PbO\\0.20\ ZnO\end{matrix}\right\}0.30\ Al_2O_3\left\{3.00\ SiO_2\right.$$

The percentage batch for this formula is as follows:

	Per cent		
Potash feldspar	30.0	Add	
English ball clay	6.9		Per cent
Flint	25.8	Borax	2.0
Whiting	5.3	Tin oxide	6.0
White lead	27.7	Sodium uranate (yellow)	1.4
Zinc oxide (calcined)	4.3		
	100.0		

V. Blue Enamel, Standard Color No. 40

This standard color is a light greenish blue color. A number of blue stains of widely different composition serve quite well in producing this color when enamel compositions are properly adjusted, but in order to reduce the number of stains necessary to be prepared and stocked, the blue enamel was developed, using the blue stain (BE 2) required in the green enamel.

The composition and preparation of the blue stain (BE 2) have been given. In addition to the blue colored stain a small amount of copper carbonate ($CuCO_3$) is used in the enamel batch as a modifier.

(1) Composition of Blue Enamel

$$\left.\begin{matrix} 0.10\ K_2O \\ 0.10\ Na_2O \\ 0.30\ CaO \\ 0.40\ PbO \\ 0.10\ ZnO \end{matrix}\right\} 0.25\ Al_2O_3 \left\{\begin{matrix} 2.50\ SiO_2 \\ 0.20\ B_2O_3 \end{matrix}\right.$$

The percentage batch for this enamel is as follows:

	Per cent		
Frit No. 3	17.8	Add	
Potash feldspar	16.2		Per cent
English ball clay	7.4	Borax	2.0
Flint	20.5	Tin oxide	8.0
Whiting	5.8	BE 2 stain	8.0
White lead	30.0	Copper carbonate	0.75
Zinc oxide (calcined)	2.3		
	100.0		

Frit No. 3 has the oxide formula $2Na_2O{\cdot}2CaO{\cdot}Al_2O_3{\cdot}4B_2O_3{\cdot}10SiO_2$ and the percentage batch is as follows:

	Per cent
Borax	44.9
Whiting	11.7
Georgia china clay (pulverized)	15.2
Flint	28.2
	100.0

The china clay is ground dry to pass 40-mesh, thoroughly mixed dry with the other ingredients, and fritted in a frit furnace.

VI. Brown Enamel, Standard Color No. 51

This standard color is a light brown, variously known as buff, tan, autumn brown, and sand. The best known stains for producing this color are

composed of mixtures of zinc oxide, ferric oxide, and chromium oxide. Manganese and nickel compounds also produce brown colorations under certain conditions but are not reliable at high temperatures.

The composition of the brown stain (T 7) is as follows:

PERCENTAGE BATCH

	Per cent
Ferric oxide (red iron oxide)	6.0
Chromium oxide (green chrome oxide)	4.0
Aluminum oxide (alumina)	40.0
Zinc oxide	50.0
	100.0

This stain is thoroughly mixed dry by hand, screened several times through a 40-mesh screen, mixed again by hand, and calcined to cone 10 in closed saggers. The calcined powder is ground wet to pass 200-mesh easily, washed free of soluble salts, dried, and pulverized.

(1) Composition of Brown Enamel The brown enamel, exclusive of opacifier and colorant, has the following empirical formula:

$$\left.\begin{matrix} 0.20\ K_2O \\ 0.10\ Na_2O \\ 0.40\ CaO \\ 0.30\ ZnO \end{matrix}\right\} 0.35\ Al_2O_3 \left\{\begin{matrix} 2.80\ SiO_2 \\ 0.20\ B_2O_3 \end{matrix}\right.$$

The percentage batch for this enamal (SC 51) is as follows:

	Per cent	Add	Per cent
Frit No. 3	20.00		
Potash feldspar	36.4		
English ball clay	8.4		
Flint	17.6	Borax	2.0
Whiting	9.8	Zirconium oxide	8.0
Zinc oxide (calcined)	7.8	T 7 stain	6.0
	100.0		

The composition and preparation of frit No. 3 have been given under the blue enamel.

VII. Black Enamel, Standard Color No. 60

This standard color is a deep bluish black of high gloss. Theoretically, black is the absence of color and is not regarded as a color. In the ceramic industry, however, black is generally regarded as a color, and is known by the accompanying cast produced by other colors. Thus, it is common to hear of blue-black, brown-black, green-black, and gray-black, when those respective colors are present.

Black is produced on enamels and glazes by a mixture of several chemical compounds. The materials most generally used to produce black are the compounds of cobalt, iron, chromium, manganese, copper, nickel, and uranium. A black stain may contain all or only a few of these coloring compounds.

No prepared stain was used in the production of this standard color, as a mixture of commercial cobalt oxide, ferric oxide, and cupric (black copper) oxide in proper proportions serves very satisfactorily as a black colorant when incorporated in an enamel of suitable chemical composition. Boric

acid ($B_2O_3 \cdot 3H_2O$) in the enamel batch intensifies the color and improves the gloss.

(1) Composition of the Black Enamel The black enamel, exclusive of boric acid and colorants, has the empirical formula as follows:

$$\left.\begin{matrix} 0.20\ K_2O \\ 0.20\ CaO \\ 0.40\ PbO \\ 0.20\ ZnO \end{matrix}\right\} 0.30\ Al_2O_3 \left\{ 3.00\ SiO_2 \right.$$

The percentage batch for this enamel (SC 60) is as follows:

	Per cent		
		Add	
			Per cent
Potash feldspar	30.0	Boric acid	6.6
Georgia china clay	6.9	Cobalt oxide	4.0
Flint	25.8	Ferric oxide	2.0
Whiting	5.3	Cupric oxide	1.0
White lead	27.7		
Zinc oxide (calcined)	4.3		
	100.0		

VIII. Preparation of the Enamels

(1) Materials The materials used in preparing these enamels and colored stains are the technically pure materials ordinarily supplied to the ceramic industry.

(2) Weighing The enamel batches are divided for convenience in weighing into two parts: the glaze proper, a complete transparent glaze calculated to a percentage batch from the empirical formula, and the additive materials to produce opacity and color. For grinding purposes the batches may be of any size according to the size of the ball mill at hand. In some cases it is desirable to weigh the coloring material and opacifier first and grind them together before adding the glaze. The green enamel, SC 11, and brown enamel, SC 51, are prepared in this manner in order to procure clearer colors in the fired enamel. When large batches are being weighed, it is best to weigh colored stains and coloring compounds separately on small, accurate scales, and add to the batch.

(3) Grinding The weighed batch is charged into a ball mill together with a known weight of water, usually 55% of the dry weight of the batch of glaze proper. The amount of water necessary varies with each enamel and should be under rather than over that required for the proper spraying density. The number of revolutions of the mill or the number of grinding hours for correct grinding should be determined for each enamel, size of batch, and ball mill. The enamels should be ground fine enough so that a sample washed through a 200-mesh screen under slow running tap water leaves no gritty residue.

IX. Application of the Enamels

(1) Dipping Small pieces of ware, such as samples, may be successfully dipped in these enamels described above. For large pieces of sanitary ware the dipping process, however, is not successful due to insufficient thickness of coating, bare edges, beads, and streaks obtained.

(2) Spraying The best results in the application of these prepared enamels are obtained by spraying. Standard spraying

equipment may be used. Uniform coatings are most easily obtained with a fish tail or flat spray from the spray gun and with air pressure at about 45 pounds per square inch.

(3) Densities of Enamels for Spraying The best results are obtained when these enamels are sprayed at definite densities. By trial, the following densities were found to give good results:

Enamel	Oz./pint	Enamel	Oz./pint
Green (SC 11)	29½	Blue (SC 40)	29½
Orchid (SC 20)	30	Brown (SC 51)	29½
Ivory (SC 30)	30	Black (SC 60)	29

The sprayed samples or ware are allowed to dry thoroughly at room temperatures before being handled or placed in the kiln.

X. Firing the Enamels

These enamels were developed for use in a 375-foot open-fire car tunnel kiln. The best results are obtained in firing when the time schedule is eighty-five hours through the kiln. The enamels mature to good colors at about cones 6 to 7 with this time schedule and have a firing range of about one and one-half pyrometric cones. The specific firing treatment for each enamel is as follows:

Enamel	Cone No. (inside sagger)	Enamel	Cone No. (inside sagger)
Green (SC 11)	6½–7	Blue (SC 40)	5½–6
Orchid (SC 20)	5½–6	Brown (SC 51)	6½–7
Ivory (SC 30)	6–6½	Black (SC 60)	5½–6

XI. Summary

The six standard colors chosen are such that they may easily be duplicated in the low-fired metal enamels and in paints and varnishes for articles of metal and wood for the bathroom. Glassware manufacturers should also be able to duplicate the colors to a fair degree without extreme difficulty.

Experience in the use of these colored enamels has shown them to be practical for colored vitreous china sanitary ware glost at cone 6. Vitreous china enamels from cones 2 to 12 may be reproduced with adjustments of the glaze proper and in some cases of the opacifier and colorants.

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A FUSION STUDY OF THE HIGH FELDSPAR AREA IN THE FELDSPAR–KAOLIN–QUARTZ SYSTEM*

By M. H. Waldschmidt

ABSTRACT

Pyrometric cone equivalent values of various mixtures of the three components are presented with some observations on deformation eutectics found and on the location of the true eutectic.

I. Introduction

Practically all ceramic bodies have as their essential constituents feldspar, kaolin, and quartz. Minor amounts of calcium, magnesium, and iron salts may also be present in commercially useful clays and bodies and titanium oxide is generally present in a small amount, but these can not be considered in the following study without rendering the system too complex for practical interpretation. A knowledge of this three-component system forms the foundation on which all study of ceramic bodies must be developed.

The only previous study of this system was by Simonis,[1] who covered the triaxial at 15% intervals. This study, although valuable, does not permit comparison of most commercial bodies with the fundamental data.

For convenience in planning the present study, the system was divided into four equal parts as follows:

(A) Those members containing 50% or more feldspar, 50% or less kaolin, and 50% or less quartz
(B) Those members containing less than 50% of any of the three constituents
(C) Those members containing more than 50% quartz, less than 50% feldspar, and less than 50% kaolin
(D) Those members containing more than 50% kaolin, less than 50% feldspar, and less than 50% quartz

Only part A was attempted as the first assignment. This portion of the system is of major importance in studying all ceramic bodies, since the glassy phase constituting the vitrifying agent is located within this area.

The various mixtures were prepared and molded into cones of the same shape and dimensions as the standard pyrometric cones. As fusion develops the first evidence of deformation of the cone is termed 1 o'clock, since the tip of the cone has moved from the vertical or 12 o'clock position to a position comparable to the 1 o'clock position on the face of a clock. When the cone has so deformed that the tip is half way between its vertical position and the level of the base on which it stands, its deformation is termed 3 o'clock, since the cone tip has assumed a position corresponding to the location of the numeral 3 on the face of a clock. When the tip of the cone touches the plaque in which it stands its deformation is termed 6 o'clock. This nomenclature is termed "clock values in deformation of cones."

The progress of deformation of a cone indicates a process of solution of

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* The research here reported includes data developed by H. W. Thiemecke, T. L. Falknor, and Henry Newhouse in 1930 and 1931. The study was completed by the writer and assembled data and conclusions were submitted and accepted as a M. Sc. thesis at Ohio State University in June, 1932. Received November 9, 1932.

[1] "Die Kegelschmelzpunkte von Gemischen aus Zettlitzer Erde, Quarz, und Feldspat," *Sprechsaal*, Nos. 29–30 (1907).

the constituents of the mixture in the glass phase developed. The rate of solution depends on the fluidity and amount of the glass phase. Thus the data on mixtures in part A of this system show the nature of the vitrifying agent in a normal ceramic body if the minor amounts of impurities and auxiliary fluxes present are ignored.

The term "deformation eutectic" is used throughout this paper to designate the composition which requires the lowest temperature to complete deformation when uniformly heated.

II. Previous Research

Figure 1 shows the P. C. E. values for the feldspar–kaolin–quartz system as found by Dr. Simonis.[2] The diagram indicates the progress of vitrification in relation to composition. Dr. Simonis determined only the end point of deformation or the 6 o'clock or down position of the test cones.

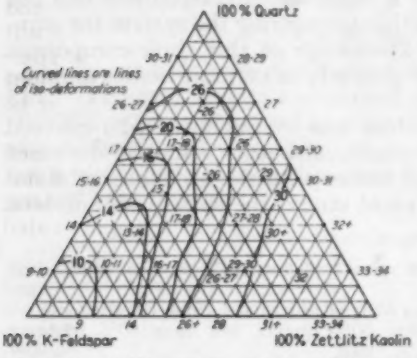

FIG. 1.—Deformation study, feldspar–quartz–kaolin system, according to Simonis. The numbers refer to Seger cones.

III. Method of Procedure

The method of study was to make up test cones (of the same dimensions as standard pyrometric cones) of compositions indicated by the various points on the feldspar–kaolin–quartz triaxial and to observe their deformation behavior when heated in comparison with the deformation behavior of standard cones undergoing the same heat treatment. Both the 1 o'clock and 6 o'clock P. C. E. values were noted. These two values are the only ones that can be definitely evaluated by cone deformation.

All members on any of the triaxials shown on the following pages are given in percentage by weight. A definite number was assigned to each member. For example, on all data sheets, member 1 is always 50% feldspar and 50% quartz.

(1) Mounting of Cones for Tests The cones were mounted in plaques at a definite angle of 83° with the horizontal. This condition makes for the elimination of different beam action and gravitational effects resulting from different cones being mounted at variable angles. The plaques containing the cones were dried in the open air for two or three days before firing.

(2) Setting and Firing of Test Cones The test cones, properly mounted, were set in a muffle kiln and surrounded with standard pyrometric cones which were set in such a manner that any variation in temperature throughout the setting might be observed. The cones were set on a series of steps cut in Armstrong insulating brick. Thus the test cones occupied the same positions in the muffle on each firing.

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[2] See footnote 1.

Test firings were made on groups of cones, each group overlapping the others so that relationships were accurately established. The kiln was fired to cone 1 in 22 hours, to cone 4 in 23 hours, and to cone 7 in 24 hours. The rate of temperature increase was then slowed down to about one cone every 30 to 40 minutes. This allowed sufficient time to watch the cone deformations. All tests followed this general schedule. Records were made of the positions of the standard cones as the test cones attained the position of 1 o'clock (start of deformation) and the position of touch or

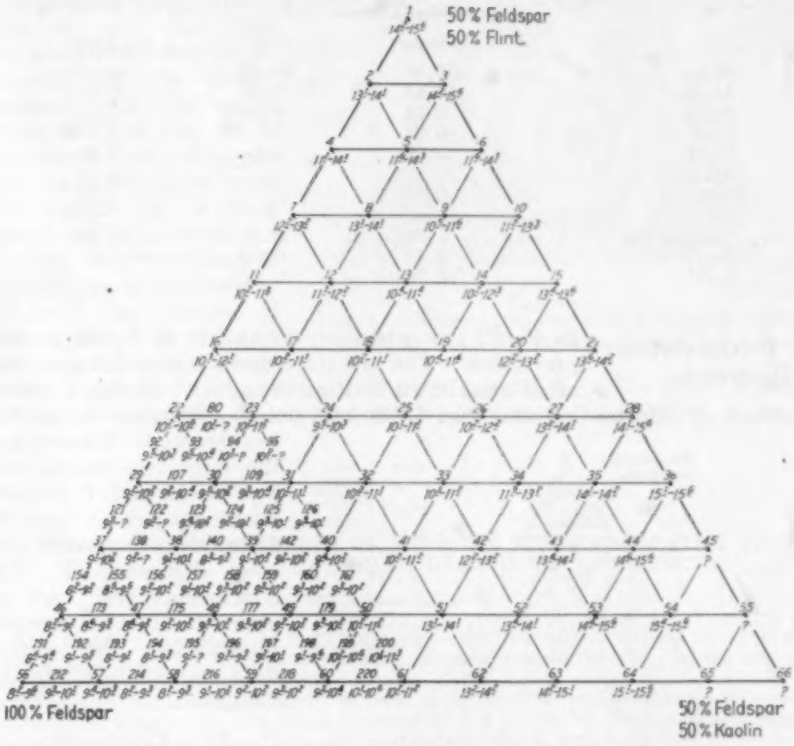

FIG. 2.—Fusion study of feldspar–quartz–kaolin system.

6 o'clock position. The deformation behavior of the cones was watched through peepholes in the kiln door.

The initial test firing covered the entire triaxial and was made for the purpose of locating general soft spots and low fusing areas. Subsequent firings were then made on groups of members whose deformation P. C. E. values were fairly close together. The final test firings were made on groups of only 14 or 15 test cones. The difference in P. C. E. value between the most refractory and most fusible cones in these final groups was never more than two standard cones. The purpose of covering the area in more than one firing was to get the smallest setting of cones possible in order to obviate any difference in temperature throughout the setting.

A recording pyrometer was used to check the rate of temperature increase, particularly before and at temperatures approaching deformations of the test cones.

(3) Materials Used The following materials were used in these tests: (1) Derry Canadian Feldspar (from Obrien and Fowler Co., Ottawa, Can.), (2) Florida kaolin (E. P. K. brand, Edgar Plastic Kaolin Co., Edgar, Fla.), and (3) Pennsylvania flint (from Pennsylvania Pulverizing Co., Lewistown, Pa.).

Chemical Analyses

	Feldspar	Flint	Fla. kaolin
SiO_2	65.36	99.69	46.95
Al_2O_3	18.45	0.04	36.75
Fe_2O_3	0.13	0.03	0.80
CaO	0.04		0.15
MgO	0.06	0.04	0.20
Alkalis			0.24
TiO_2	0.01		0.18
P_2O_5	trace		
Ignition loss	0.28	0.10	14.95
Na_2O	2.43	0.09	
K_2O	12.76	0.02	

(4) Interpretation of Diagrams In Fig. 2 the compositions and P. C. E. ranges are presented. The triaxials divided into deformation areas are shown in Figs. 3 and 4. Figure 3 shows the start of deformation and Fig. 4, the end point of deformation of the test cones. These are the only two points (the 1 o'clock and 6 o'clock positions) which can be definitely evaluated by cone deformation. The conclusions given are all approximate; for specific information the actual data would have to be consulted.

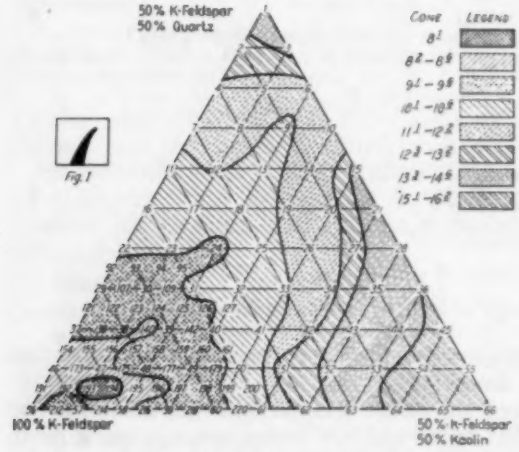

FIG. 3.—Deformation study of K-feldspar–quartz–kaolin system. 1 o'clock position of test cones.

IV. Conclusions

(1) The deformation ternary eutectic between feldspar, kaolin, and quartz is found to be 92.5% feldspar, 5.0% kaolin, and 2.5% quartz.

(2) The deformation binary eutectic between feldspar and quartz is found to be 95.0% feldspar and 5.0% quartz.

(3) The deformation binary eutectic between feldspar and kaolin is found to be 92.0% feldspar and 8.0% kaolin.

(4) The lowest fusing composition found in this investigation is the deformation eutectic, not the true eutectic. Microscopic examination of

the lowest melting test cone showed the presence of undissolved quartz. No other crystal phase was discernible. Therefore the actual eutectic lies not at the composition point of the test cone but on a line projected from the 100% quartz point through this eutectic composition point and somewhere between the composition point of the test cone and the line representing 0.0% quartz. Due to the fact that the so-called "zone of influence" of the potash feldspar grain is small, the solution of the quartz crystals is very sluggish, and since the cones were not soaked for a long period and hence were not brought to a condition of equilibrium, it is necessary to have an excess of quartz present in order to have a continuous phase of the eutectic composition, since only a portion of the quartz grains has sufficient time to dissolve no matter how great a proportion of quartz be present in the body.

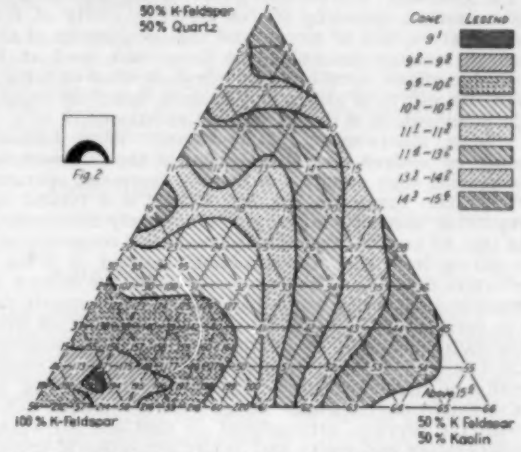

FIG. 4.—Deformation study of K-feldspar–kaolin–quartz system. 6 o'clock position of test cones.

DISCUSSION ON "CONVERSION OF PERIODIC KILNS FROM COAL FIRING TO NATURAL GAS FOR FIRING GLAZED CLAY PRODUCTS"*

BY CHARLES F. GEIGER

Mr. Grady's discussion of the "Carboradiant" direct-fired method of operating ceramic kilns does not present an entirely accurate account of the purpose and advantage of this form of construction.

Essentially the "Carboradiant" method of firing kilns was introduced to permit the direct oil-firing of glazed ceramic products previously fired in coal- or oil-fired muffle kilns. If the "Carboradiant" kiln will permit direct-firing, with oil as fuel, of products that formerly were of necessity fired in muffle kilns, then obviously the "Carboradiant" kiln offers decided advantages to those now using coal- or oil-fired muffle kilns.

Experience with a wide variety of installations has shown that glazed ceramic products can be fired in the direct-fired "Carboradiant" kiln without any sacrifice of quality and, because of elimination of the muffle, with a consequent large decrease in fuel consumption. Bearing in mind that the "Carboradiant" kiln is intended as a substitute for a muffle kiln, Mr. Grady's statement regarding initial and maintenance costs, is incorrect. Actual experience with these kilns shows that the initial cost is no higher than the muffle kiln construction and that maintenance costs are considerably lower.

In the discussion of the "Carboradiant" kilns used by the Fords Porcelain Works Mr. Grady is quite correct that the large fuel saving is due to the removal of the muffle, but it is certainly only fair to stress the fact that this particular plant is now producing the same high quality of ware as formerly obtained from muffle kilns with a tremendous

* See R. F. Grady, Jr., *Jour. Amer. Ceram. Soc.*, **16** [3], 141–51 (1933).

saving in operating cost over muffle kiln operation and is in a locality where gas-firing is out of the question.

It is unfair to draw comparisons between the firing time used at Fords Porcelain Works and that of some other plant, basing conclusions as to the suitability of the "Carboradiant" kiln on such a comparison, without a complete study of all the features of operation, including size of kiln, uniformity of temperature obtained, final firing temperature, size of pieces, and the peculiarities of the body being fired. These important factors determine the firing time used at Fords Porcelain Works. Other "Carboradiant" fired kilns are being operated on firing periods as low as 15 to 18 hours and still others in excess of 100 hours and these variations in firing time are fixed by the combination of the factors just mentioned.

Some plants using "Carboradiant" kilns, formerly equipped with direct-fired, coal-, or oil-fired kilns, have installed the "Carboradiant" construction as a means of improving ware quality and thereby decreasing operating costs. The 36-foot diameter round kiln mentioned by Mr. Grady is a typical example. Mr. Grady's remarks regarding this installation give an entirely erroneous idea of what was accomplished in that he assumes that the decreased fuel consumption and improved heat distribution resulting from the "Carboradiant" method of firing are due to a reduction in the effective diameter of the kiln. Actually, the 36-foot dimension is the inside diameter measured between main outside walls. As formerly fired with burners located around the periphery of the kiln heavy bag walls were set within the kiln effectively reducing the 36-foot diameter by the thickness of the bag walls and the width of the flue between the bag walls and the main kiln wall. The "Carboradiant" chambers occupy substantially no more total area than that formerly used by the bag walls and flues, and the weight of the charge in the "Carboradiant" kiln is no different from that fired with the previous arrangement so that any advantage in quality due to improved temperature uniformity and better atmospheric control, or any improvement in fuel consumption, can be attributed to the use of the "Carboradiant" system and not, as stated, to an assumed reduction in the effective diameter of the kiln.

The Carborundum Company
Perth Amboy, New Jersey

CERAMIC ABSTRACTS[1]

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Vol. 12 **April, 1933** **No. 4**

Abrasives

Automatic measurement during grinding. I. American practice. Reviewed by S. A. MCDONALD. **II. British practice.** Reviewed by F. HORNER. *Mech. World*, **93** [2402], 36–40 (1933).—The dial indicator by which gaging is done without having to stop the machine is a diamond-pointed finger which bears against the surface being ground and shows the amount ground away. Thus the work can be rough ground down to near size, the wheel dressed, and the finishing cut taken. In British practice the sizing gage for plain, universal, and crankshaft grinders can be mounted either on the table or on the wheel guard. The gage has three contact points, the blocks being of special abrasion-resisting steel to ensure long life. Sizes can be held within one or two ten-thousandths of an inch. After the first piece has been sized the operator leaves the gage in contact with each succeeding component during grinding and watches the gage needle move back to zero where the sizing is effected and the process stopped. Output may often be increased 25 to 75% as compared with ordinary hand-measurement methods. E.P.R.

Revised federal specifications for waterproof garnet paper. ANON. *Abrasive Ind.*, **14** [2], 19–20 (1933). E.P.R.

Metallographic emery paper. ANON. *Laboratory*, **5** [4], 66–67 (1932).—The making of emery paper for polishing metallographic specimens is described. Control tests on the screening and sedimentation of emery, adhesive properties of the glue, and physical properties of the paper are discussed. Illustrated. F.G.H.

Movies depend upon abrasives. A. B. LAING. *Abrasive Ind.*, **14** [2], 8–10 (1933).—Because of the almost infinite variety of finishes that can be attained through the use of abrasives, art directors of motion picture firms rely upon them to obtain definite photographic effects. E.P.R.

Grinding applications in modern manufacture. F. HORNER. *Machinery* [London], **39** [1005], 485–89 (1932); abstracted in *Mech. Eng.*, **54** [4], 309 (1932).—Recent developments in cylindrical, form, roll, centerless, internal, and surface grinding are described in detail. F.G.H.

Grinding rolls for rolling mills. H. J. WILLS. *Iron Age*, **128** [27], 1683–85 (1931); abstracted in *Mech. Eng.*, **54** [4], 311 (1932).—Roll grinding and finishing in the sheet-steel, tin-plate, steel-plate, sheet-brass, copper, and aluminum industries are described. Roll grinding machines, abrasive wheels for roll grinding, and the coolant preparation are discussed. F.G.H.

Grinding tools tipped with tungsten and tantalum economically. J. M. HIGHDUCHECK. Presented at the Dec. meeting of A.S.M.E. Abstracted in *Abrasive Ind.*, **14** [2], 21–23 (1933).—H. describes the practice employed at the Westinghouse Electric & Mfg. Co. E.P.R.

Grinding set-ups used in centerless method. A. D. MEALS. *Abrasive Ind.*, **14** [2], 14–16 (1933).—M. cites briefly the advantages claimed for centerless grinding, and describes the set-ups used on work of a simple nature with data on wheels, amount of metal removed, and production rates. E.P.R.

[1] The abbreviation (*C.A.*) at the end of an abstract indicates that it was obtained from *Chemical Abstracts* by coöperative agreement.

The bold-face number following the journal name is the volume, the issue number is in brackets followed by the page numbers, then the year in parentheses.

Halving splineshaft grinding time. ANON. *Mech. World*, **92** [2398], 576–77 (1932).—In a new method of grinding splineshafts, three wheels are arranged on one spindle and trued by a diamond setting gage which is prepared for each design of splineshaft. Production time is said to be halved by this method. E.P.R.

Chattering in cylindrical grinding overcome by simple remedies. FRED B. JACOBS. *Abrasive Ind.*, **14** [2], 11 (1933).—The most common causes of vibration are loose wheel spindle, too hard a wheel, worn wheel slide, loose head or foot stock, improper centers in the work grinding machine, centers worn out of shape, incorrect relation between the wheel and work speed, lack of backrests, wheel out of balance, wheel not trued correctly, and end play between the centers and the work. E.P.R.

Regrinding worn bearing raceways to increase service. W. G. GUDE. *Abrasive Ind.*, **14** [2], 17–18 (1933).—A reground bearing is regarded as practically the equal of a new bearing. E.P.R.

Simple jigs used in grinding parts for machine tools. ANON. *Abrasive Ind.*, **14** [2], 12–13 (1933).—The jig must be constructed with the least number of moving parts so that the minimum time is lost in placing the piece of work in the jig and removing it. E.P.R.

Corundum in South Africa. A. W. CARRUTHERS. *Official Yearbook of S. Africa*, **13**, 468 (1932).—The Bandolierkop district has been worked since 1914. Demand is principally from America. Producers are now sending out only clean, well-graded crystals. The gravel from which the crystals are washed and screened is 2 ft. in thickness and contains 5 to 10% corundum. The sale of 6000 T. amounted to £44,900. H.H.S.

BOOK

Machine Tool Work. WILLIAM P. TURNER. 424 pp. McGraw-Hill Book Co. Reviewed in *Abrasive Ind.*, **14** [2], 18 (1933).—The grinding machine and grinding methods are treated briefly in Chapter XVI. E.P.R.

PATENTS

Heat treatment of garnet abrasive. E. W. COLT (Armour & Co. of Delaware). U. S. 18,730, Feb. 7, 1933 (reissue).

Cam grinding machine. J. C. SHAW AND R. D. SHAW (Pratt & Whitney Co.). U. S. 18,733, Feb. 14, 1933 (reissue). LLYWELYN MAWER (Churchill Machine Tool Co., Ltd.). U. S. 1,894,382, Jan. 17, 1933.

Work clamping fixture for crank grinding machines. A. P. STEINER (Landis Tool Co.). U. S. 18,736, Feb. 14, 1933 (reissue).

Traveling wheel grinder. F. K. BENEDICT (Hanchett Mfg. Co.). U. S. 1,895,122, Jan. 24, 1933.

Worktable and relieving mechanism for grinding machines. E. A. WALKER (John Bath). U. S. 1,895,830, Jan. 31, 1933.

Centerless grinding machine. R. A. COLE (Cincinnati Grinders, Inc.). U. S. 1,896,481, Feb. 7, 1933.

Shaping or dressing apparatus. ALBERT VUILLEUMIER (New Departure Mfg. Co.). U. S. 1,896,533, Feb. 7, 1933.

Rubbing block. J. M. GAUSS (Studebaker Corp.). U. S. 1,896,946, Feb. 7, 1933.

Grinding machine. C. J. ANDERSON. U. S. 1,897,035, Feb. 14, 1933.

Polishing and grinding machine. C. L. HAWES. U. S. 1,897,049, Feb. 14, 1933.

Tool grinding machine. LEONHARD KELLENBERGER. U. S. 1,897,055, Feb. 14, 1933.

Machine tool spindle. F. C. HOAGLAND (Pratt & Whitney Co.). U. S. 1,897,666, Feb. 14, 1933.

Grinding head and drive. J. G. DICKSON. U. S. 1,897,891, Feb. 14, 1933.

Polishing tool. D. R. JOHNSTON (Fisher Body Corp.). U. S. 1,897,971, Feb. 14, 1933.

Abrasive compositions suitable for molding. CELLULOID CORP. Brit. 359,324, Oct. 28, 1931. Abrasives are mixed with cellulose acetate or other suitable cellulose ester or ether and the usual plasticizers, solvents, fireproofing substances, etc. (*C.A.*)

Articles of bonded granular material and methods of making. NORTON CO. Brit. 385,328, Jan. 4, 1933.

Means for use in examining the contours of gear-wheel teeth. GEAR GRINDING CO., LTD., AND J. W. SNARRY. Brit. 385,411, Jan. 4, 1933.

Universal grinding and backing-off grinding apparatus for twist drills, screw taps, center punches, lathe centers, etc. J. WEISSINGER. Brit. 385,746, Jan. 11, 1933.

Method of forming abrasive articles. E. Garner and Carborundum Co., Ltd. Brit. 385,788, Jan. 11, 1933.

Machines for grinding splined shafts, gear-teeth, etc. Gear Grinding Co., Ltd., and J. W. Snarry. Brit. 385,791, Jan. 11, 1933.

Locomotive crank-pin grinding and quartering machines. Churchill Machine Tool Co., Ltd., and H. H. Asbridge. Brit. 385,878, Jan. 11, 1933.

Grinding apparatus for slicing machines. G. A. Smith and F. W. Williams. Brit. 386,364, Jan. 25, 1933.

Grinding, polishing, etc., machines. G. F. Porritt and J. N. Porritt. Brit. 386,399, Jan. 25, 1933.

Grinding apparatus for flat surfaces. E. Hanus and Oemeta Chemische Werke Ges. Brit. 386,506, Jan. 25, 1933.

Machine for grinding the inner surfaces of cylinders, etc. K. Jung. Brit. 386,885, Feb. 1, 1933.

Abrasives. I. G. Farbenind. A.-G. Fr. 724,726, Oct. 17, 1931. Abrasives are made resistant to water by using as binders mixed esters, capable of being hardened, of polyalcohols in which the OH groups are esterified partly by a higher fatty acid and partly by polybasic carboxylic acid or synthetic resinic acids. (*C.A.*)

Abrasives, etc. Compagnie française pour l'exploitation des procédés Thomson-Houston. Fr. 726,718, Aug. 26, 1931. Hard carbides of metals of the 5th group are agglomerated by metals of the Fe group or their alloys (25% of the total weight). The cohesion is obtained by compression in the cold followed by fritting. (*C.A.*)

Art and Archeology

Ceramic colors for glass decoration. E. R. Box. *Glass*, **10** [1], 13 (1933).—Fired-on colors are usually enamels which must mature at temperatures lower than those at which the glass itself will "sag." The higher the maturing temperature of the enamel, the greater is its resistance to wear and corrosion. The use of opacifier, application of the color, and firing are discussed. Underfiring is the biggest source of trouble and the most frequent cause of failure. Transparent colors are usually more easily handled than opaque colors. G.R.S.

Glass models of invisible creatures made for museum. Anon. *Popular Sci. Monthly*, **121** [2], 46 (1932).—The making of glass models of invisible aquatic creatures at the American Museum of Natural History is described and illustrated. F.G.H.

Elizabethan glass panel. C. Louise Avery. *Bull. Met. Mus. Art*, **27** [12], 257–59 (1932).—A painted glass panel with coat of arms recently acquired by the Museum was made in England about 1570 and displays the arms of the Killigrew family of Cornwall. The panel is square, is mounted in a simple molded oak frame, and is designed to hang from one corner. The under surface is decorated with paint in various colors with a background of silver foil. A.A.A.

Sources of underglaze-blue decoration. F. C. Dykes. *Trans. English Porcelain Circle*, **1**, 25 (1928). (*Trans. Ceram. Soc.* [Eng.])

Tradition and experiment in pottery design. W. A. Thorpe. *Pottery Gas.*, **58** [668], 223–26 (1933).—Tradition in pottery is a conservation from each previous period of what has been most successfully achieved and the conversion of this into an instinct. Various important considerations in good design are discussed. E.J.V.

Egyptian blue on pottery. Anon. *Chem. Trade Jour.*, **92** [2383], 42 (1933).—As a result of the close study of the cracked bezel of a finger ring, it was found that the color was not due to the glaze of a surface coating of enamel but permeated the whole mass, though in varying degrees of intensity. The density of color deepened outward. By experiments it has been proved that the coloration is due to the reaction of soda on copper oxide contained in the pottery body. During firing, moisture is expelled from the center, dissolving soda and conveying it to the surface. It comes in contact with the copper and intensifies the blue as the soda is forced outward. Recalling Josiah Wedgwood's experience with his jasper ware which was originally colored throughout the mass and later applied as a slip by dipping, it is possible that the Egyptian blue might also be obtained by means of a specially prepared engobe or slip. M.V.K.

White pottery. Anon. *Amer. Home*, **9** [2], 47 (1933).—Examples of milk-white pottery with decorations in low relief are illustrated. F.G.H.

Modern Indian pottery. C. N. Millington. *Amer. Mag. Art*, pp. 450–54 (June, 1932). (*D.I.*)

Mexican pottery. ANON. *Amer. Home*, **9** [2], 47 (1933).—Color and design in Mexican pottery are portrayed by four pieces of Aztec Indian ware. F.G.H.

European decorative arts in the Michael Friedsam collection. JOSEPH BRECK. *Bull. Met. Mus. Art* (Sec. 2), **27** [11], 62–68 (1932).—This collection includes some twenty-five examples of Italian majolica decorated with pictorial subjects as well as pure ornament. The majority came from Urbino, others from Faenza, Castel Durante, and Deruta. There are also four German porcelain statuettes of the 18th Century representing the seasons. A Spanish lustered plate of the 15th Century from Valencia and ten English 18th Century pieces, eight by Wedgwood and two by Adams, are included. There are also twenty-seven painted enamels made at Limoges in the 16th and 17th Centuries. The collection given by Mr. Morgan in 1917 was of the earlier Champlevé Limoges enamels of the 12th and 13th Centuries. Some of these earlier enamels are in the Friedsam collection which is on view in the Gallery of Special Exhibitions through April, 1933. A.A.A.

Recent discoveries. ANON. *Trans. English Porcelain Circle*, **3**, 66 (1931).—Papers by various authors on Caughley porcelain, excavations at Chelsea in 1843, the Limehouse China Factory, a Longton Hall advertisement, inscribed Longton Hall mugs, old porcelain wall brackets, and inscribed and dated "scratch-cross" pieces are presented. (*Trans. Ceram. Soc.* [Eng.])

Caughley porcelain before 1772. A. HURST. *Trans. English Porcelain Circle*, **1**, 22 (1928).—Evidence is advanced to show that both porcelain and earthenware were produced at Caughley before 1772. (*Trans. Ceram. Soc.* [Eng.])

Soft paste Bristol porcelain and the intimate relationship of the factory at Lowdin's Glasshouse with Limehouse and Worcester. W. ELLIOT. *Trans. English Porcelain Circle*, **2**, 6 (1929). (*Trans. Ceram. Soc.* [Eng.])

Chinese influence on shape and decoration in English porcelain. W. W. WINKWORTH. *Trans. English Porcelain Circle*, **3**, 64 (1931). (*Trans. Ceram. Soc.* [Eng.])

Earliest references to Chelsea porcelain. H. B. GARDNER. *Trans. English Porcelain Circle*, **1**, 16 (1928).—A number of references from *The Daily Advertiser*, dated 1749 to 1750, are reproduced. (*Trans. Ceram. Soc.* [Eng.])

Chelsea birds. H. B. GARDNER. *Trans. English Porcelain Circle*, **3**, 55 (1931). (*Trans. Ceram. Soc.* [Eng.])

Inscribed and dated Lowestoft porcelain. A. J. B. KIDDELL. *Trans. English Porcelain Circle*, **3**, 7 (1931). (*Trans. Ceram. Soc.* [Eng.])

Gift of ornamental Wedgwood. C. LOUISE AVERY. *Bull. Met. Mus. Art*, **27** [11], 237–38 (1932).—A vase and pedestal of green jasper ware are among the fourteen pieces of Wedgwood given to the Museum by the late Frank K. Sturgis. These pieces are representative of the large ornamental styles as developed in his famous jasper ware. There are nine blue jasper vases, besides a pair of green jasper urns on pedestals. There are some examples of black basalt and a vase of cream ware with marbleized glaze and gilt decoration. Two black basalt urns by Neale, contemporary of Wedgwood, are also shown with this gift. A.A.A.

Porcelain illustrating skating. W. KING. *Brit. Museum Quarterly*, **6**, 102–103 (1932).—The British Museum has received a gift of 26 pieces of Vienna, Meissen, and English ware illustrating the history of skating. H.H.S.

Drug jars and their significance. E. F. ARMSTRONG. *Chem. & Ind.*, **51** [51], 1029–30 (1932).—The drug jars of the 17th Century made by the potters of Lambeth are discussed. G.R.S.

An early allusion to English porcelain, Gouyn's will, and some Chelsea models. H. B. GARDNER. *Trans. English Porcelain Circle*, **2**, 23 (1929). (*Trans. Ceram. Soc.* [Eng.])

Liverpool porcelain. B. RACKHAM AND W. B. HONEY. *Trans. English Porcelain Circle*, **2**, 27 (1929). (*Trans. Ceram. Soc.* [Eng.])

Early work of Planché and Duesbury. (MRS.) D. MACALISTER. *Trans. English Porcelain Circle*, **2**, 45 (1929). (*Trans. Ceram. Soc.* [Eng.])

Raku ware and its present trend. MITSUHIKO OMORI. *Jour. Jap. Ceram. Assn.*, **40** [468], 654–57 (1932).—Raku ware is the most popular earthenware in Japan. It was probably originated by Ameya of Kioto in the Eisho period. His son, Chojiro Tanaka, studied the art of making the black Korai ware in Korea and started his kiln in the 5th year of Tensho. He is called the first of the Raku House. Donyu, third of the House, invented a method of keeping the luster of its glaze by taking the ware from the kiln while they were still hot. Famous makers of the ware in Tokugawa dynasty are Tamamizu ware, Chobei, Kyubei, Ohi ware, Toyosuke ware, Kenzan Ogata, Hakyu Ogawa, and Kenya Miura. The special feature of the ware is that it can be made by anyone of

any clay. Hitherto, it has been related too much with the tea services. O. advises its makers to manufacture wall tile, lamp stands, cigar sets, and other goods. S.K.

Kaki-emon designs. W. W. WINKWORTH. *Trans. English Porcelain Circle*, **1**, 7 (1928).—An account is given of the work of the Japanese potter, Kaki-emon, and his school. (*Trans. Ceram. Soc.* [Eng.])

Bourmas of Bahr-Sara. G. GEO-FOURRIER. *Art et Déc.*, pp. 157–60 (May, 1932).—Bourmas are the fired clay vases in which the natives of Oubanghi, Africa, carry water. Through a peculiar firing process and a special varnish derived from the bark of a native tree, the vases acquire a lustrous black, while the decoration stands out in dull red. Illustrated. (*D.I.*)

Revival of the manufacture of peasant ware in the environs of Uherske Hradiste (Moravia). V. STANCL. *Zprávy Československ. keram. společnosti*, **8**, 190 (1931).—Ware produced prior to 1890 in this district having been in great demand for private collections, the manufacture of this household pottery has been reintroduced. The recent copies can always be distinguished by the trade mark, UHD. The raw material is washed ferruginous clay. Biscuit is fired at cone 08 and glost (lead-tin glaze) at cone 010. The ware is molded and painted by hand only. (*Trans. Ceram. Soc.* [Eng.])

Life and work of William Billingsley. W. H. TAPP. *Trans. English Porcelain Circle*, **2**, 62 (1929). (*Trans. Ceram. Soc.* [Eng.])

Excavations at St. Albans, England. ANON. *Popular Sci. Monthly*, **121** [5], 54 (1932).—A beautifully designed mosaic tile floor has been unearthed at St. Albans. Illustrated. See also *Ceram. Abs.*, **10** [5], 324 (1931). F.G.H.

Oxford excavations at Hira, 1931. D. TALBOT RICE. *Antiquity*, **6** [23], 276–91 (1932).—Some fifty miles south of ancient Babylon, excavations were made at Hira. Among articles found were large pottery vessels which were probably used as drains as they were under floors. Some fragments of delicate glass were found but the pottery fragments were abundant. One fine blue glazed pot with an impressed decoration probably dates from Sasanian times. Some pieces of unglazed ware are thought to be Sasanian; others belong to known types of barbotine ware and are definitely of Moslem date. There were also commoner pots bearing a grafitto decoration around the neck and shoulders. A.A.A.

Greek terra cotta statuette. G. M. A. RICHTER. *Bull. Met. Mus. Art*, **27** [12], 250–52 (1932).—A famous Greek terra cotta has been purchased by the Museum and placed in the Room of Recent Accessions. It is an ancient reproduction, less than one-quarter life size, of the Diadoumenos of Polykleitos, one of the most celebrated statues of antiquity. As the original work has long since disappeared this statuette is unusually valuable. It belongs to a group of terra cotta figures found mostly in Smyrna which reproduce famous statues of different periods. Most of these statuettes are fragments but this one is quite well preserved. A.A.A.

BOOKS

Origin of the Indian Civilizations in South America. ERLAND NORDENSKIÖLD. One of three portions of Vol. 9. Comparative Ethnographical Studies. Edited by E. Nordenskiöld. iv + 205 pp. Oxford University Press, London, 1931. 18s 6d net. *Nature*, **130** [3287], 647 (1932).—N. examines the Indian cultures of South America in detail with a view to determining how far they have been introduced from outside and how far they have developed on the spot. By means of tables of geographical distribution, he shows that a considerable number of elements have a wide enough range from the north of North America to the south of this continent to be regarded as belonging to basic Indian culture. Variations in South American Indian cultures are held to be developments in response to local conditions, *e.g.*, cultures of the tropical belt. The cultivation of domesticated food plants peculiar to America and metal working are regarded as being distinctive of American culture and are purely local. N. sets aside any resemblances between Melanesian and American languages as outside his province. As to cultural affinity, he argues that any introduction from Oceania must be extremely remote. He supports his contentions by a mass of detailed evidence. J.L.G.

Key of All Wales. JOHN LYNN-THOMAS. Foreword by Vincent Evans. 115 pp. Western Mail, Ltd., Cardiff, 1932. Price 5s 6d. Reviewed in *Times Lit. Supp.*, **31**, 735 (1932).—Surprising relics of prehistory in Cardiganshire have been found on the mound at Llwyndyrys. H.H.S.

PATENTS

Design for refrigerator cabinet. C. C. THOMAS (Kelvinator Corp.). U. S. 89,098, Jan. 24, 1933.

Design for coffee pot, etc. CHARLES KAISER (Morimura Bros., Inc.). U. S. 89,193 and 89,194, Feb. 7, 1933.

Design for sugar bowl, etc. CHARLES KAISER (Morimura Bros., Inc.). U. S. 89,195, Feb. 7, 1933.

Design for cream jug, etc. CHARLES KAISER (Morimura Bros., Inc.). U. S. 89,196, Feb. 7, 1933.

Design for lavatory. W. J. KOHLER, JR., AND F. G. BROTZ. U. S. 89,200, Feb. 7, 1933.

Design for electric range. ALFONS BARNSTEINER (Westinghouse Electric & Mfg. Co.). U. S. 89,251, Feb. 14, 1933.

Design for nursing bottle. M. H. BLOCK (Harry Kortz, D. A. Block, and Phillip Kleiger). U. S. 89,252, Feb. 14, 1933.

Design for bottle. C. A. FULLE, JR. U. S. 89,257, Feb. 14, 1933.

Design for globe. H. H. BLAU (Macbeth-Evans Glass Co.). U. S. 89,273, Feb. 14, 1933.

Design for lighting fixture globe. M. B. CHERNIAK. U. S. 89,274, Feb. 14, 1933.

Pottery bird house. J. B. LENHART. U. S. 1,894,406, Jan. 17, 1933.

Bird bath. EMMETT BURLEY. U. S. 1,895,702, Jan. 31, 1933.

Cements

Tentative methods of testing gypsum and gypsum products. ANON. *Proc. A.S.T.M.*, **32** [Part I], 700–10 (1932).—Specifications and a method of testing for free water in gypsum and fineness are given. Chemical analysis of gypsum and calcined gypsum, testing consistency, tensile and compressive strengths of gypsum plaster, compressive strength and absorption of gypsum partition tile or block, and flexural strength of gypsum boards are described. R.A.H.

British standard specifications for Portland blast-furnace cement. ANON. British Standard Specification, No. 146 (1932); *Concrete Constr. Eng.*, **27** [8], 486 (1932).—This revised edition is required owing to the revision of the British standard specification for Portland cement, and the changes introduced bring the physical tests in the specifications into agreement. The 28-day mortar test has been eliminated, a new 3-day test being inserted so that the periods for the tensile tests on cement and sand are 3 and 7 days. The quantity of water required for preparing the neat-cement paste or cement and sand mortar is determined by a modification of the Vicat plunger method, the percentage of water necessary to produce a prescribed settlement of the plunger into a pat of neat cement being multiplied by a factor. Tables are given for obtaining the required percentages without calculation. F.G.H.

Effect of composition of Portland cement on heat evolved during hardening. H. WOODS, H. H. STEINOUR, AND H. R. STARKE. *Ind. Eng. Chem.*, **24** [11], 1207–14 (1932).—The heat evolved during setting and hardening was determined at 3, 7, 28, 90, and 180 days for a number of Portland cements of varied composition. The cements are mixed neat with 40% of water and are stored at 35°C in sealed bottles. Heat liberation is determined by the heat of solution method. The results are analyzed by the method of least squares for the contribution of each per cent of each compound to the total heat evolution on the assumption that a linear relationship exists between the compound composition of a cement and its heat evolution. The compounds comprised in this analysis are tricalcium aluminate, tricalcium silicate, tetracalcium aluminoferrite, and β-dicalcium silicate. R.G.M.

Hardening of Portland cement. J. LOVENTHAL. *Rev. mat. constr. trav. pub.*, No. 279, p. 519 (1932).—L. discusses the theories of Kühl (*Ceram. Abs.*, **11** [9], 479 (1932)) and Tippman dealing with the hardening of Portland cement and describes the results obtained by the Danish testing laboratory which are contrary to the theory of Tippman, *viz.*, that a complete hydrolysis of calcium silicates of the clinker takes place and that the final products are a silica gel and calcium hydroxide. L. assumes that the increase in the soluble silica content is due to the formation of a hydrosilicate of lime soluble in dilute HCl; this theory is consistent with Tippman's theory of the complete hydrolysis. See also article by Koyanagi, *ibid.*, **12** [3], 93 (1933). M.V.K.

Formation of calcium silicates, aluminates, and ferrites in the process of clinkering Portland cement. J. KONARZEWSKI. *Przemysl Chem.*, **16**, 165–85 (1932).—The velocity of reaction between $CaCO_3$ and acidic oxides increases in the order $Al_2O_3 < SiO_2 < Fe_2O_3$. Al_2O_3 catalyzes the reaction between CaO and SiO_2 only at a temperature at

which a liquid phase exists, while Fe_2O_3 catalyzes even in the solid phase. See also *Ceram. Abs.*, **11** [8], 441 (1932). (*B.C.A.*)

Magnesia content of Portland cement. SEIJI KONDO AND SADATSUGU WADA. *Jour. Jap. Ceram. Assn.*, **40** [480], 769–79 (1932).—Portland cements with varying compositions were prepared. The ratio $SiO_2:Al_2O_3:Fe_2O_3$ remained the same for all clinkers. In Group 1, MgO contents varied from 1.25 to 12.00%, hydraulic modulus being 2.00 for all clinkers. In Group 2, hydraulic modulus was changed from 1.77 to 2.10, MgO content being kept constant at 8.00%. It is concluded that the MgO content can safely be allowed up to 8% and that a part of the MgO probably reacts with Fe_2O_3 at first, the remainder forming a solid solution with tricalcium silicate to a certain limit. S.K.

High lime Portland cements. I. Preliminary experiments. SEIJI KONDO AND HIROSHI YOSHIDA. *Jour. Jap. Ceram. Assn.*, **40** [476], 500–506 (1932). S.K.

Study of metallurgical Portland cements. II. P. DUMESNIL. *Rev. mat. constr. trav. pub.*, No. 279, pp. 488–93 (1932); for Part I see *Ceram. Abs.*, **12** [3], 93 (1933). M.V.K.

Study of calcium aluminates. III. Microscopic investigation of their hydration. SEIJI KONDO AND TOSHIYOSHI YAMAUCHI. *Jour. Jap. Ceram. Assn.*, **40** [472], 212–33 (1932).—Three different crystals of hydrated calcium aluminate were found: (*A*) In needles, columns, or hexagonal plates; n_D, $\omega = 1.498$, $\epsilon = 1.507$; optically uniaxial and positive. (*B*) In needles, columns, hexagonal plates, or spherulites; n_D, $\omega = 1.524$, $\epsilon = 1.506$; optically uniaxial and negative. (*C*) In needles or hexagonal plates; n_D, $\omega = 1.535$; $\epsilon = 1.511$; optically uniaxial and negative. In the pure samples, the hydration proceeded in the following manner: (1) $3CaO\cdot Al_2O_3$. At first, crystals *A*, then crystals *B* and a small amount of $Al(OH)_3$, and, at last, crystals *C* were produced. (2) $5CaO\cdot 3Al_2O_3$. First, a trace of *A*, then *B*, and lastly $Al(OH)_3$ and *C*; sometimes slender needles were observed. (3) $CaO\cdot Al_2O_3$. Slender needles and *B*, then much $Al(OH)_3$ and *C*. (4) $3CaO\cdot 5Al_2O_3$. *B*, much $Al(OH)_3$, and *C*. The samples fired insufficiently hydrated like $3CaO\cdot Al_2O_3$ at early stages producing crystals *A* and then like each corresponding pure aluminate, though much slower. The crystals *A*, *B*, and *C* may be considered as $3CaO\cdot Al_2O_3\cdot xH_2O$, although indications are that the crystals *A* produced in the hydration of $3CaO\cdot Al_2O_3$ and all samples containing free lime over certain amounts are probably $4CaO\cdot Al_2O_3\cdot xH_2O$ or the solid solutions of $3CaO\cdot Al_2O_3\cdot xH_2O$ and $Ca(OH)_2$. Fifty-one microphotographs are given. **IV. Time of setting and compressive strength.** *Ibid.*, **40** [474], 349–58 (1932).—The time of setting, the rise of temperature in the setting, and the small piece compressive strength of the samples obtained by heating 4 mixtures, $3CaCO_3\cdot Al_2O_3$, $5CaCO_3\cdot 3Al_2O_3$, $CaCO_3\cdot Al_2O_3$, and $3CaCO_3\cdot 5Al_2O_3$, at temperatures ranging from 1200 to 1500°C have been measured. The relation between the strength and the microstructure is also discussed. For Parts I and II see *Ceram. Abs.*, **11** [7], 401 (1932). S.K.

Influence of chromic oxide and alumina upon the formation of tricalcium silicate. SEIJI KONDO AND KESAKICHI MOTEKI. *Jour. Jap. Ceram. Assn.*, **40** [477], 559–64 (1932).—Raw mixtures composed of C.P. materials were heated at 1530°C for 2 hr. and the products were examined for chemical composition, small-piece compressive strength, and microstructure. The results of the microscopic observations indicate that chromic oxide forms a solid solution with tricalcium silicate. This may be a cause of the high strength of the products. S.K.

Action of media with an alkaline reaction on the crystallization of aluminates of lime and the setting of aluminous cements. SEAILLES. *Ind. chimique*, **19** [227], 910 (1932).—The setting and hardening of aluminous cements cause a normal phenomena in the presence of lime, even in minimum quantities. The setting becomes too rapid so that mixing is impossible and the hardening is deficient. S. studied the conditions of crystallization of lime aluminates in solution. It was found that the crystallization of these aluminates is a function not only of the index p_H determined by the lime in solution, but it is generally the function of the index p_H regardless of the nature of the base which it determines. Replacing the lime solution by a soda or potash solution gives identical results and an immediate precipitation. In the case of soda the reaction is $4(Al_2O_3\cdot CaO) + CaO + nH_2O = Al_2O_3\cdot CaO\cdot 12H_2O + 3(Al_2O_3\cdot 3H_2O) + CaO(OH_2) + nH_2O$. The mechanism of setting is discussed in detail. The p_H index which defines the alkalinity of the medium is of prime importance since it determines the strength and nature of the hydrated lime aluminates which are formed from anhydrous aluminates. M.V.K.

Constitution of magnesium oxychloride. W. DAWIHL. *Tonind.-Ztg.*, **56** [62], 781–82 (1932).—The paper by H. S. Lukens (*Ceram. Abs.*, **12** [1], 7 (1933)) is discussed.

It is pointed out that the constitution of the precipitate investigated may be different from that of the precipitate formed by concentrating the magnesium chloride solution by magnesium oxide. See also *ibid.*, **11** [3], 158 (1932). W.M.C.

Some experiments with plaster. R. N. JOHNSON. *Pottery Gaz.*, **58** [667], 63–66 (1933); see following abstract. E.J.V.

Investigations of the setting of plaster of Paris. IV. Sodium and potassium borates and their effects on the setting. C. S. GIBSON AND R. N. JOHNSON. *Jour. Soc. Chem. Ind.*, **51** [51], 400–403 (1932).—Solutions of each borate at all concentrations retard the setting of plaster and, in general, the retarding power increases with the concentration. The borates at all concentrations reduce the expansion of plaster on setting, and at concentrations up to 0.1*N* they are comparable with such powerful agents as K_2SO_4. All the borate solutions, under the conditions specified, yield products of greater hardness than can be obtained with water alone, and at the same time the expansion may be greatly diminished. Maximum hardness is attained slowly. See also *Ceram. Abs.*, **11** [6], 344 (1932). G.R.S.

Alite, tricalcium silicate, and dicalcium silicate. VIERI SEVIERI. *Rev. mat. constr. trav. pub.*, No. 279, pp. 485–88 (1932).—S. reviews and discusses different theories dealing with alite and tricalcium and dicalcium silicates and the setting and hardening of Portland cement. See also article by Jänecke and Brill, *Ceram. Abs.*, **12** [3], 94 (1933). M.V.K.

Hydration of alumina cement. I. KATSUZO KOYANAGI. *Jour. Jap. Ceram. Assn.*, **40** [476], 489–99 (1932).—Hitherto, 2 equations were proposed on the hydration of alumina cement: (*a*) by Le Chatelier and Duhameaux (1927), $2(5CaO{\cdot}3Al_2O_3) + 38H_2O = 5(2CaO{\cdot}Al_2O_3{\cdot}7H_2O) + Al(OH)_3$; (*b*) by Koyanagi (1930), $2(CaO{\cdot}Al_2O_3) + 11H_2O = 2CaO{\cdot}Al_2O_3{\cdot}8H_2O + Al_2O_3{\cdot}3H_2O$. Further studies showed that $Ca(OH)_2$ in the solution was exhausted. The main hydration begins, *i.e.*, $CaO{\cdot}Al_2O_3$ changes to $2CaO{\cdot}Al_2O_3{\cdot}7.5H_2O$ losing $^1/_2$ mol. of Al_2O_3: $2(CaO{\cdot}Al_2O_3) + 10.5H_2O = 2CaO{\cdot}Al_2O_3{\cdot}7.5H_2O + Al_2O_3{\cdot}3H_2O$. Hardening is generally due to this reaction. S.K.

Rôle of iron in aluminous fused cements. HANS RICHTER. *Zement*, **21** [32], 445–49; [33], 457–62; [34], 471–76; [35], 485–89 (1932).—Iron oxide occurs as $2CaO{\cdot}Fe_2O_3$ and not as $CaO{\cdot}Fe_2O_3$ in fused aluminous cement. In the presence of sufficient $CaO{\cdot}Al_2O_3$ the double compound, $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$, is formed. Compounds higher in lime do not react with the iron groups. The presence of iron compounds retards the setting process generally with the exception of $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$. The strength of normal aluminous cement increases with the iron content. Fused cement of good quality should contain not more than 6% SiO_2 and 15% Fe_2O_3. The lime content should be controlled so that $2CaO{\cdot}SiO_2$, $CaO{\cdot}Al_2O_3$, and $2CaO{\cdot}Fe_2O_3$ result. M.V.K.

Influence of raw-material components on the kind of cement and on the firing process. R. ZOLLINGER. *Zement*, **21** [29], 419 (1932).—The constituents are discussed as to their effect on the formation of furnace rings, the consumption of fuel, and the finished cement. It was found that the replacement of Al_2O_3 with Fe_2O_3 reduces the fuel cost but increases the liability to oversaturation with CaO. The calcination of $CaCO_3$ and the reaction with SiO_2 and R_2O_3 take place simultaneously. M.V.K.

Hydraulic value of cements. V. SEVIERI. *Ann. chim. applicata*, **21** [12], 545–52 (1931); abstracted in *Chim. & ind.*, **27** [6], 1350 (1932); *Ind. chimique*, **19** [227], 910 (1932).—Free lime or lime combined with the radicals TiO_2, Fe_2O_3, and Mn_2O_3 has no hydraulic value. M.V.K.

Care needed in thermal calculations of cement rotary kiln and waste-heat boiler. EIJI TAKAHASHI. *Jour. Jap. Ceram. Assn.*, **40** [473], 285–90 (1932).—Thermal study of cement rotary kiln and waste-heat boiler based on gas analysis sometimes leads to an erroneous conclusion. The chief cause probably lies in the difficulties in getting fair samples and correct temperatures of the gases in question. Three examples are given. S.K.

PATENT

Cement and articles of cement and method for producing. D. R. E. WERNER, S. GIERTZ-HEDSTRÖM, AND O. STÄLHANE. Brit. 386,924, Feb. 1, 1933.

Enamels

Technique of vitreous enameling. J. E. HANSEN. *Brit. Ind. Finishing*, **3** [25], 5–9; [27], 49–53; [28], 75–78 (1932).—H. discusses in detail (1) the application of the enamel, (2) dipping sheet-iron ground coats, (3) spraying the liquid enamel, (4) care of the spray gun, (5) spraying cast-iron enamel, (6) spraying sheet-iron enamels, (7) spraying black edging enamels, (8) the effect of too small charge of frit on the color and

gloss of the enamel, (9) drying and brushing enamel, (10) firing cast-iron enamel, sheet-iron ground coats, and sheet-iron cover enamels, and (11) firing grained enamels, stencils, and decalcomanias. Practical suggestions for burners are given. See also *Ceram. Abs.*, **11** [7], 403 (1932). M.V.K.

Production of iron-red enamel. ANON. *Glashütte*, **62** [48], 853–54 (1932).—Iron oxide, Fe_2O_3, is used for iron-red enamel. It is obtained from iron ores, minerals, or iron solutions, especially sulfate. The finely ground raw mass must be carefully elutriated to remove all soluble ingredients. A better preparation will be obtained if the content of Fe_2O_3 is large and the content of FeO and salts soluble in water, especially chlorides and sulfates, is small. The frit for iron red is opacified slightly and must be thoroughly melted. The raw materials should contain as little FeO as possible because the purity of the color and the covering power decrease with a high FeO content. Iron oxide must be present as a colloid and be finely distributed in the enamel coat. The frit must melt easily to avoid high-temperature reductions and to prevent the dissolving of the iron oxide particles. The mixture of raw materials must contain as little as possible of materials which act as reducers or decrease the fusibility. Materials increasing the fusibility (borax, sodium fluoride), those that have an oxidizing action, and those promoting the color should be present in large quantities. The frit should be saturated with alumina to avoid high additions of clay to the mill. A black ground is objectionable, a pure cobalt or white ground being preferable. Mixing should be thorough and short; the slip can be kept only for a short time. The drying must proceed rapidly (vacuum drying chambers are best). The firing is the most difficult part of the manufacture of iron-red enamel. Firing with gas is objectionable. Muffles should be closed and the fire should be oxidizing. The temperature must be constant, and mechanical testing and registering apparatus are necessary. M.V.K.

Fishscales in ground enamel for sheet metal. H. LANGE. *Glashütte*, **62** [45], 801–803 (1932).—In criticizing the hydrogen theory of the appearance of fishscales in enamels, L. points out that practice shows that with a certain composition and a special manufacture of the ground enamel the appearance of fishscales may be avoided. When firing the ground enamel, care should be taken not to melt the enamel too much so that the refractory constituents of the enamel are not completely decomposed. This is important because the usual additions to the mill (clay, quartz, etc.) may be given up. It has been found that ground enamels rich in feldspar and poor in fluorspar are inclined to form fishscales which decrease markedly when the fluorspar content is increased. Enamels low in feldspar or without it form fishscales with an increased addition of feldspar. The correct proportion of quartz : feldspar : fluorspar is essential to obtain an enamel free from fishscales. M.V.K.

Physics and chemistry of nickel pickling. FRANK R. PORTER. *Better Enameling*, **4** [1], 18–19 (1933).—P. discusses the effect of the metal surface on enamel coatings. A nickel bath composition is given and ionization and deposition of the nickel are described. Need for control of the process is required and the reasons are given. See also article by Hofstetter, *Ceram. Abs.*, **12** [3], 96 (1933). W.W.M.

Note on the fusibility of sodium silicate and possibilities of its employment in enamel work. ALBERT DEBECQ. *Rev. belge ind. verrières, céram., émail.*, **3** [4], 82–83 (1932); for abstract see *Ceram. Abs.*, **12** [3], 96 (1933). P.E.C.

Production and significance of barium carbonate for the enamel industry. OSKAR KERSTAN. *Glashütte*, **61**, 133–34 (1931); *Chem. Zentr.*, **II**, 3376 (1931).—K. discusses the transformation of barite into BaS when worked in the reducing atmosphere of a revolving furnace, when dissolved in water, and when $BaCO_3$ is precipitated by CO_2. M.V.K.

Barium oxide as a constituent of enamels. OTTO KERSTAN. *Glashütte*, **61**, 769–72 (1931); *Chem. Zentr.*, **II**, 3376 (1931).—K. recommends the use of barium oxide for different enamels and discusses several batches. M.V.K.

Grinding enamel. ANON. *Glashütte*, **62** [50], 883–85 (1932).—A detailed discussion of grinding and of different mills is given. M.V.K.

Heat-resisting metals in the ceramic industry. J. F. KAYSER. *Chem. Age*, **27** [695], 386–87 (1932); *Foundry Trade Jour.*, **47** [846], 263–65; [847], 280–81 (1932); for abstract see *Ceram. Abs.*, **12** [2], 69 (1933). (*B.B.N.F.M.R.A.*)

Volume changes of cast iron during casting. C. M. SAEGER, JR., AND E. J. ASH. *Trans. Amer. Foundrymen's Assn.*, **3**, 172–87 (1932).—Volume changes of eight types are recorded. The coefficient of liquid shrinkage over the temperature range studied was 0.011% per 1°. During solidification, gray Fe expanded 1.65% while low-C, low-Si Fe contracted 5.85%. All gray and white cast irons undergo expansion during or immediately after solidification. It begins at 1130° and is maximal at 1070°. (*B.C.A.*)

Controlling steel foundry sand. A. V. LEUN. *Foundry*, **60** [11], 30–60 (1932).—A detailed description is given of the methods employed and the apparatus used in testing sands, clays, core oils, corn flour, resin binders, bentonites, and silica flour. Illustrated. F.G.H.

Cylindrical cores in loam. TECHNICAL COMMITTEE OF THE BELGIAN FOUNDRY ASSN. *Fonderie Belge*, June and July, 1932; abstracted in *Foundry*, **60** [14], 62 (1932).—The making of loam cylindrical cores by hand, in special frames or core molds, and with a strickle board is described in detail. F.G.H.

Vitreous enameling materials and supplies. I. W. C. CUMMINGS. *Clay Prod. News*, **6** [1], 13–14 (1933).—C. discusses in alphabetical order the materials and supplies used in vitreous enameling including abrasives, acids, air, ammonium carbonate, anti-scale compound, asbestos mitts, base metal, borax, brushes, firing equipment, cast iron, canvas gloves, clay, cleaner, coloring oxides, and decalcomanias or transfers. W.W.M.

Fundamental factors contributing to adherence of enamel. I. ANSON HAYES. *Better Enameling*, **4** [1], 6–8 (1933); for abstract see *Ceram. Abs.*, **12** [3], 95 (1933). W.W.M.

Enameling technique. KARL MEURES. *Glashütte*, **62** [45], 789–93 (1932).—M. discusses in detail researches dealing with the manufacture, firing, adherence, and opacity of enamels. Bibliography. M.V.K.

Enamel industry applications. Heating with heavy oils. P. GHEYSEN. *Rev. belge ind. verrières*, **2**, 268–71 (1932); *Jour. Soc. Glass Tech.*, **16**, 149*A* (1932).—Fuel oils, burners for heavy oils, and Mahler burners are discussed. Refractories for use in oil-burning furnaces containing 42 to 44% and 70% alumina are considered. (*C.A.*)

Study of enamel. SHIZUTA MORIYASU. *Jour. Jap. Ceram. Assn.*, **40** [471], 167–76; [472], 248–53; [475], 437–43; [479], 714–21 (1932).—A thorough survey on the literature of enamel is given. S.K.

Architect and porcelain enamel. BENNETT CHAPPLE. *Enamelist*, **10** [4], 15 (1933). W.W.M.

People may live in steel houses. PAUL H. HAYWARD. *Nation's Business*, pp. 38–42 (Dec., 1932).—H. states that $1000 all-steel cottages are available and $5000 all-steel houses are promised. W.W.M.

Dry-process enamels for signs. L. STUCKERT. *Ceram. Age*, **20** [4], 140–41 (1932).—S. discusses enamels for signs, and colored, transparent, majolica, mat, acid-resistant, and other enamels. Compositions and limits are included. Desirable properties for each type are discussed. Bibliography. R.G.M.

Chip-proof enamelware. FEDERAL ENAMELING & STAMPING CO. *Enamelist*, **10** [4], 22 (1933).—A chip-proof, stainless enamelware is about three times as heavy as other ware and sells to dealers for $45 for an assortment of 30 pieces. Each utensil is guaranteed. W.W.M.

Control system for the modern enameling plant. GLENN A. HUTT. *Enamelist*, **10** [4], 7–10 (1933).—H. describes a control system which includes pickle room, mill room, application, and firing and inspection. He defines the term "control system" and outlines the benefits derived from such a system. Type control charts are included with the method of laying out the control system. W.W.M.

Practice in the enamel shop. L. STUCKERT. *Ceram. Age*, **20** [6], 216–18 (1932).—S. presents a general discussion of enamel shop practice. R.G.M.

Enameling: yesterday, today, and tomorrow. R. D. LANDRUM. *Ceram. Age*, **20** [4], 143–63 (1932). R.G.M.

BOOK

Foundrywork and Metallurgy. Vol. IV. Edited by R. T. ROLFE. 229 pp. Isaac Pitman & Sons, London and New York. Reviewed in *Foundry*, **60** [13], 52 (1932).—Melting, one of the major problems of foundry practice, receives principal attention in this section of the series on foundrywork and metallurgy. Types of melting units including the reverberatory furnace, rotary furnace, crucible furnace, noncrucible furnaces, and electric melting units are described in detail. F.G.H.

PATENTS

Heat insulated cooking vessel. A. T. SMITH (National Enameling & Stamping Co.). U. S. 1,895,212, Jan. 24, 1933.

Scullery tank and table. W. F. ROESCHER. U. S. 1,897,713, Feb. 14, 1933.

Yellow coloring materials for ceramics and enamels. LUDWIG STUCKERT (Deutsche Gold- und Silber-Scheideanstalt vorm. Roessler). Ger. 554,607, Jan. 15, 1931; see also Fr. 727,012, *Ceram. Abs.*, **12** [3], 98 (1933). (*C.A.*)

Glass

Atomic arrangement in glass. W. H. ZACHARIASEN. *Jour. Amer. Chem. Soc.*, **54** [10], 3841–51 (1932).—Z. shows that the following picture of the atomic arrangement is in complete agreement with the characteristic properties of glasses. The atoms in glass are linked together by essentially the same forces as in crystals. Over large ranges of temperature the atoms are oscillating about definite equilibrium positions. As in crystals, extended three-dimensional networks are formed. The principal difference between a crystal network and a glass network is the presence of symmetry and periodicity in the former and the absence of periodicity and symmetry in the latter. A glass network with an energy content comparable to that of the corresponding crystal can be formed only under certain conditions. These conditions are deduced for oxide glasses. It is found that the following oxides may be expected to occur in vitreous forms: B_2O_3, SiO_2, GeO_2, P_2O_5, As_2O_5, P_2O_3, As_2O_3, Sb_2O_3, V_2O_5, Cb_2O_5, Ta_2O_5. Analogously it is deduced that BeF_2 is the only fluoride which can be prepared as glass. In a similar manner it is found that an oxide glass of the general type must contain appreciable amounts of one or more of the following types of cations: B^{+3}, Si^{+4}, Ge^{+4}, P^{+5}, As^{+5}, As^{+3}, P^{+3}, Sb^{+3}, V^{+5}, Sb^{+5}, Cb^{+5}, Ta^{+5}, Al^{+3}. The gross chemical composition of a glass can be expressed by a formula $A_m B_nO$ where B represents the cations listed above and A represents all other cations present; m and n give the number of cations A and B per oxygen atom. It is concluded that a glass will have the most advantageous properties if n has a value of about 0.5. Cations A must carry a small charge and have a large radius. These restrictions concerning the chemical composition are in complete agreement with empirical facts. Some conclusions with respect to other properties of oxide glasses are given. R.G.M.

Permeability of various glasses to helium. W. D. URRY. *Jour. Amer. Chem. Soc.*, **54** [10], 3887–3901 (1932). R.G.M.

Results of introducing volcanic ash into glass. N. A. PENTKA AND A. S. RASUMOV. *Keram. i Steklo*, **8** [10], 17–21 (1932).—The influence of volcanic ash on the economical conditions, technological processes, and properties of photo plate glass has been studied. It was found that (1) the quantity of alkalis required is considerably lower; (2) the cost of the batch is slightly increased; (3) the melting rate of the batch is higher; (4) the working conditions of the tank furnace remain unchanged except for a higher temperature at the working end; (5) the corrosion of the refractories of the tank is considerably diminished; (6) with the water content of the ash equal to 3% the mixing of the batch is almost perfect; (7) the specific gravity of the glass is higher; (8) the coefficient of expansion is smaller; and (9) the transparency seems to increase. M.V.K.

Behavior of glassforming oxides under high oxygen pressure. H. MÖTTIG. *Glashütte*, **62** [48], 852–53 (1932).—Analytical investigations of technical glasses (Salmang) show that the glassforming oxides BaO and PbO may be present in glass in a higher degree of oxidation. Corresponding glasses were melted under high oxygen pressure (up to 350 atmosphere) and investigated as to their oxygen content. It was found that BaO_2 can be present in glass. This agrees with the observations of Springer when he used decolorizers containing barium. Higher lead oxides may be present in glass only when the simultaneous presence of alkalis permits the formation of plumbate. This can be explained by the fact that the oxygen pressure of PbO_2 is strongly reduced through the formation of alkali plumbates or alkaline earth plumbates. Glasses containing manganese show a strong deepening of color when melted under increasing pressure of oxygen. Almost black-violet glasses result under 300 atmosphere of O_2-pressure and an addition of 0.1% MnO. Dissociation equilibriums result between MnO and Mn_3O_4 which depend on the oxygen pressure, temperature, and the basic glass. M.V.K.

Dielectric properties of different glasses in relation to frequency and temperature. M. J. O. STRUTT. *Arch. Elektrotech.*, **25**, 715 (1931).—An imperfect dielectric is characterized by the two quantities, (*a*) tangent of the angle of loss, and (*b*) the dielectric constant, the former being represented by tan δ and the latter by ϵ, these quantities arising from the existence of the two components of current passing through a condenser, *viz.*, the ohmic current and the displacement current. With the aid of an alternating current bridge, accessory air condensers, and inductionless resistances, both tan δ and ϵ can be determined for the frequency range, 50 to 2.10^4 Hertz. For higher frequencies up to 5.10^5 Hertz, an oscillating circuit and a substitution method are employed, a variable air condenser giving the required comparison. Glass in the form of tubes 30 cm. in length with the middle 10 cm. silvered is used, and measurements can be made at temperatures up to 300°, an electric furnace with the usual thermocouple method of temperature measurement making this possible. Five glasses varying in chemical

composition between Pyrex and a lead glass were examined, and, as the same type of glass gave differing results (to the extent of 40%) for different melts of the same type of glass, mean values were taken for not less than 10 specimens in each case. The observed values for tan δ over the temperature range, 30 to 260°, and for frequencies 50 to 3.10^5 Hertz fulfilled the empirical formula, $\tan \delta = A \cdot e^{\alpha \cdot T}$, T being the temperature and A and α depending on the type of glass and on the frequency. Actually, α decreases with increasing frequency. The results obtained were not in agreement with the hypothesis that all dielectric losses are attributable to the ohmic conductivity. For ϵ, there was an increase with rising temperature for all frequencies, the rise being more rapid for a fixed temperature at low frequencies (50 Hertz) than at higher (10^5 Hertz). Although the behavior of ϵ could be explained qualitatively on the dipole theory, the relations for tan δ were more complex than would appear probable on such a theory. (*J.S.G.T.*)

Analysis of glass and its raw materials. V. I. PANASIUK AND I. PISARENKO. *Ukrain. Khem. Zhur.*, **7** [Tech.], 1–4 (1932).—For analysis $\leqslant 50$ g. of glass should be used. SiO_2 is determined by titrating the precipitate of K_2SiF_6; if this is thoroughly washed, the results differ by $\geqslant 0.04\%$ from those obtained gravimetrically. (*B.C.A.*)

Relation between shape and size of glassmelting pot and its durability. MASANOBU NAKATSUJI. *Jour. Jap. Ceram. Assn.*, **40** [476], 511–15 (1932).—The round pot is most durable although rectangular and oval pots are beneficial in heat economy. The inverted cone shape as generally used in Japan is advantageous in drying and heating, but a cylindrical pot is dynamically better. In Japan the capacity of a glasspot is usually 230 kg. of glass per cubic meter, and the ratio of height to width varies from 1 : 0.74 to 1:0.82. Theoretically, 1:1 ratio is best. Representative formulas for thickness are thickness of side wall s = thickness of bottom $b \times {}^3/_4$; $s \times b$ = height × diameter/100. Formulas used by N.'s works are given. For closed pot, thickness of dome = $(s + b)/3$; b = maximum diameter/12. For Japanese closed pot, s = maximum diameter/20. S.K.

Researches on the glassy state with a dilatometer. O. KOERNER AND H. SALMANG. *Glashütte*, **62** [48], 852 (1932); for abstract see *Ceram. Abs.*, **11** [2], 86 (1932). M.V.K.

Solubility of lead glasses in water. I–III. KENSUKE EGAMI. *Jour. Jap. Ceram. Assn.*, **39** [462], 369–75; [463], 436–42; [464], 516–21 (1931).—A part of the results are given which were obtained by experiments carried out to show the relation of composition of glass *vs.* its resistance to weathering from its solubility in water. The compositions were expressed by the formulas: $x K_2O \cdot 2SiO_2$ $(1 - x)Na_2O \cdot 2SiO_2$–$zPbO \cdot 2SiO_2$–$ySiO_2$. The samples were rod shaped. The solubility was compared by the amount of HCl required to neutralize the dissolved alkali which was determined by potentiometric titration using hydrogen electrode. The determination of the alkali was carried out considering the effects of CO_2 and SiO_2 because of the existence of 2 transition points on the titration curves and the relation of the last potential difference *vs.* the required amount of HCl. Summarizing the results for S ($N/500$HCl in cc.) $= f(x)$, $S = f(y)$, and $S = f(z)$, E. gives $S = a(m_1 - x)^{-n_1}$ $a = f(y, z)$, $S = b(y + m_2)^{-n_2}$ $b = f(x, z)$, and $S = c(z + m_3)^{-n_3}$ $c = f(x, y)$, all being hyperbolic curves (n_1, m_1, n_2, m_2, n_3, and m_3 are constants not related to the composition). The above formulas may be combined for $S = f(x, y, z)$ as $S = K(m_1 - x)^{n_1}(y + m_2)^{-n_2}(z + m_3)^{-n_3}$, where K is a constant. The numerical values of these constants for the experimental conditions are $K = 6.68$, $m_1 = 1.56$, $m_2 = 0.46$, $m_3 = 0.95$, $n_1 = 2.38$, $n_2 = 1.69$, and $n_3 = 5.6$. Since the formulas, $S = f(x)$, $S = f(y)$, and $S = f(z)$, can be expressed by simple hyperbolic curves, differences in the solubility of lead glasses are due to differences in the solubility of $K_2O \cdot 2SiO_2$, $Na_2O \cdot 2SiO_2$, and their solvated molecules under fixed conditions, and these silicates probably do not form more complicated double compounds. S.K.

Progress of the glass industry in 1931. OSCAR KNAPP. *Glashütte*, **62** [51], 897–98 (1932).—K. gives a short review of the latest investigations dealing with (1) composition and use of household glass, (2) weather stability of glasses, (3) acoustic properties of bottle glass, (4) behavior of bottle glass under exterior influences and resistance to beer, (5) development of safety glass, (6) progress in the production of prism glasses for illuminating purposes, (7) manufacture of photographic lenses, (8) production of black glass, (9) processes taking place during etching of glass, (10) crystals appearing on chemical etching, (11) dissolving the surface of glass, (12) grinding and polishing spectacle glass, (13) galvanic silvering of glass, (14) manufacture of salmon red glass, and (15) progress in the production of quartz mirrors. See also *Ceram. Abs.*, **12** [3], 103 (1933). M.V.K.

Glass opacification. G. GEHLHOFF, H. KALSING, AND M. THOMAS. *Ind. chimique*, **19** [221], 429 (1932); for abstract see *Ceram. Abs.*, **10** [10], 683 (1931). M.V.K.

Lithium and its application. G. NAIN. *Ind. chimique*, **19** [227], 882–85 (1932).—N. describes the principal deposits of the world and the production of lithium. Lepidolite and amblygonite (particularly) are used in the glass industry. The mineral is pulverized and added to the melted glass; it should be free from iron, tourmaline, quartz, and other foreign materials. Lepidolite has the property of reducing the viscosity of the melted mass and helps in the production of white and opal glasses. In the case of the latter, the fluorine of the lepidolite acts as a flux and as an opacifier and may constitute up to 28% by weight of the melted mass. When using it instead of cryolite in the manufacture of opal glasses, the refractory walls of the glasspots are much less corroded. Lepidolite also lowers the coefficient of dilatation of the glass. The devitrification of the glass is retarded, and a harder glass surface is obtained which preserves its luster even in moist air. Lithium fluoride is utilized in the ceramic and enamel industries. Lepidolite, when used instead of feldspar in the manufacture of porcelain, gives a product of fine appearance and great whiteness which has a high resistance to sudden increase in temperature. Its utilization by other industries is discussed. M.V.K.

Further systematic study of glasses containing boric oxide and silica. E. J. GOODING AND W. E. S. TURNER. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 21 (1933). G.R.S.

Decolorizing by selenium in batches containing a volatile constituent. M. PARKIN AND W. E. S. TURNER. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 21 (1933). G.R.S.

Use of feldspar in glass manufacture. V. V. KELSEY. *Amer. Glass Rev.*, **52** [18], 9–10 (1933). E.P.R.

Softening range of glass and its definition. K. V. STRUVE. *Keram. i Steklo*, **8** [10], 31–32 (1932).—S. discusses methods used for determining the softening range of glass and some investigations made at the Lenzos works dealing with this question. M.V.K.

Lime as a constituent of glass. J. LE BRAZ. *Glaces et Verres*, **6** [31], 2–8 (1932).—The significance of lime and its rôle in glassmelting, lime raw materials, and the composition of some pure calcareous materials of France are discussed. The advantages and disadvantages of using carbonate of lime in the glass composition are as follows: (1) Lime facilitates the fusion. (2) It ameliorates the refining, making the glass less viscous at high temperatures. (3) Glass becomes less soluble; in particular, window glass is more resistant to weather and becomes more resistant to chemical agents. (4) Lime diminishes the brittleness of glass and increases its mechanical properties and elasticity. (5) More brilliancy is obtained with lime than with alkalis. On the other hand, lime diminishes the plasticity of the glass and its working is more difficult. Its chief defect is the tendency to devitrification, forming silicate of lime which crystallizes in the form of wollastonite. M.V.K.

Demonstration of measurement of particle size and concentration in opal glasses. C. DUNBAR. *Trans. Opt. Soc.* [London], **33** [3], 135 (1932).—An oil immersion microscope with a magnification of approximately 500 diameters was used to measure the particle size in opal glass. The number of particles per unit volume was measured by changing the focal depth of the microscope. The change in depth was measured by means of an interferometer system with one plate on the barrel of the microscope. The concentration of the particles in the opal glass was approximately 5×10^{16}/cm.^{3} J.T.L.

Some aspects of the manufacture of opal glass. W. M. HAMPTON. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 20–21 (1933); see also *Ceram. Abs.*, **12** [3], 101 (1933). G.R.S.

Opal glass. ANON. *Chem. Trade Jour.*, **92** [2381], 7 (1933).—A discussion of a paper by W. M. Hampton on "The manufacture of opal glass" (see preceding abstract) is given. It was found that tin oxide markedly increases opacity, but reduces the light-output ratio considerably. Change from soda to potash slightly increases the opacity for a given fluorine content. Boric oxide used in part substitution for silica gives a greater light-output ratio, but decreases the opacity seriously. The importance of founding control in the production of an opal glass for flashing is stressed, since the coefficient of expansion of an opal glass varies depending on the rate of crystal growth. M.V.K.

Opal glass. A résumé of the work of the B. S. I. subcommittee ELG-3-2 on light-diffusing glass. S. ENGLISH. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 16 (1933). G.R.S.

Theory and specification of opal-diffusing glasses. I. J. W. RYDE AND B. S.

COOPER. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 16–19 (1933). II. J. W. RYDE, B. S. COOPER, AND W. A. R. STOYLE. *Ibid.*, **10** [1], 19 (1933). G.R.S.

Increase of the iron content in glass when using cullet from the blowpipe in the batch. V. I. MOZHEIKO. *Keram. i Steklo*, **8** [10], 32–33 (1932).—A formula is given to calculate the increase of the iron oxide content in the batch which occurs when the glass remaining on the blowpipe is added to the batch in the form of cullet. M.V.K.

Relation between composition and specific gravity of glass. II. SHIZUTA MORIYASU. *Jour. Jap. Ceram. Assn.*, **39** [460], 218–30 (1931).—The specific gravity of Na_2O–SiO_2 and Na_2O–CaO–SiO_2 glasses given by Peddle, English and Turner, and Morey and Merwin have been compared with the result that the values were found to agree within 0.008, and the specific gravity could never be obtained from the formula of Winkelmann and Schott. M. has obtained the following experimental formulas to express the result of Morey and Merwin: $D = (-0.000148r + 0.01556)q + 1.529(r + 15)^{0.1263}$ or $D = (-0.000148r + 0.01556)q + \text{antilog}(0.1263 \log(r + 15) + 0.1844)$, where r = weight per cent of Na_2O and q = weight per cent of CaO. The above formulas also agree with Peddle's result. For Part I see *Ceram. Abs.*, **11** [7], 405 (1932). S.K.

Chemical durability of glass. KIYOSHI UEDA. *Jour. Jap. Ceram. Assn.*, **39** [468], 802–806 (1931).—Descriptions and discussions are given on the results of experiments made by U. and others on the chemical durability of glasses. Conclusions are as follows: (1) Internal and superficial chemical durabilities of glass change by heat treatment or acidic gas. (2) The durability diminishes by heat treatment, the effect growing marked at the annealing temperature and up. (3) Acidic gas makes the glass surface notably durable. The effect is much more than that of variation in the glass composition. (4) The durability of the glass surface is decreased by steam, its action being most intense at about 500°C. S.K.

Studies on glass. VI. Some specific heat data on boron trioxide. S. BENSON THOMAS AND GEORGE S. PARKS. *Jour. Phys. Chem.*, **35**, 2091–2102 (1931).—A fairly accurate "radiation" calorimeter was developed for use between room temperature and 500°. With this apparatus the heat capacities of B_2O_3 glass and liquid were measured between 35 and 350° with a probable absolute error of less than 4% and with a reproducibility for comparative purposes of about 0.5%. The heat-capacity curves obtained by heating a "metastable" glass, by heating a well-annealed glass, and by slowly cooling the liquid to produce the annealed glass were compared. **VII. Conductivities and dielectric constants of glucose and boron trioxide glasses.** S. BENSON THOMAS. *Ibid.*, **35**, 2103–11 (1931).—In the temperature interval in which glucose changes from a viscous liquid to a hard glass both electric conductivity and dielectric constant are functions of the viscosity; there is no discontinuity in these properties between the liquid and glassy states. Measurements of the conductivity and dielectric constant of a series of B_2O_3–sodium borate solutions support the conclusions arrived at in the case of glucose. (*C.A.*)

Spectacle glasses. TORU TAKAMATSU. *Jour. Jap. Ceram. Assn.*, **40** [478], 642–45 (1932).—Spectacle glasses are optically anisotropic and consist of parallel layers. Consequently, they are made of sheet glass composed of silica 70 to 75%, soda 12 to 14%, and lime 10 to 12%. n_D is 1.519 in most of the glasses. Their durability was examined.

	Dissolved alkali in milligrams	Classification
7 imported glasses	0.50–0.77	3 ordinary
Japanese P	0.60	3 ordinary
Japanese C.O.T.	0.51	3 ordinary
6 Japanese glasses	1.52–3.57	5 deficient

S.K.

Design of molds for glassware. H. W. HOWES. *Pottery & Glass Rec.*, **14** [12], 358 (1932); for abstract see *Ceram. Abs.*, **12** [2], 56 (1933). M.V.K.

Mold materials and design. THOMAS WARDLEY. *Pottery & Glass Rec.*, **14** [12], 358 (1932); for abstract see *Ceram. Abs.*, **12** [2], 57 (1933). M.V.K.

Devices for bending pane and plate glass. ANON. *Glashütte*, **62** [50], 881–83 (1932).—Illustrated. M.V.K.

Modern electrical production of window glass by the Fourcault and the Colburn processes. GUSTAV SPENGLER. *Siemens-Z.*, **10**, 193–98 (1930).—The two processes are briefly described, emphasis being laid on electrical equipment. (*C.A.*)

Efficiency of Fourcault machines. L. N. SHEKHIROV. *Keram. i Steklo*, **8** [10], 10–13 (1932).—Observations made on the efficiency of Fourcault machines at the Ivotski mechanized glassworks are discussed. M.V.K.

Modern glass bottle making machinery. ANON. *Mech. World*, **92** [2398], 580 (1932).—The Hillman machine, which is fully automatic and of the rotary suction type, is entirely electrically operated from a remote control switchboard. E.P.R.

Recovery of waste heat of glass tank furnace. SANGORO TAKAHASHI. *Jour. Jap. Ceram. Assn.*, **39** [463], 460–65 (1931).—The utilization of the waste heat of glass tank furnaces is discussed in regard to (1) waste-heat boiler, (2) waste water produced by cooling tank blocks, and (3) recovery of the heat radiated from the furnace. S.K.

Developments of kiln construction. A. SCHACK. *Arch. Eisenhüttenwesen*, **5**, 193–208 (1931–32); *Glastech. Ber.*, **10** [7], 399–400 (1932); for abstract see *Ceram. Abs.*, **11** [7], 418 (1932). M.V.K.

Practical data for the construction of glass tank furnaces. B. F. KUZMICH. *Keram. i Steklo*, **8** [10], 23–28 (1932).—K. discusses the construction of Dinas walls and the crowns of tank furnaces. M.V.K.

Notes on the manufacture of special glasses. XI. Colorless glasses. ANON. *Glass*, **10** [1], 8–12 (1933).—The discussion of the use of special ingredients is continued under the topics, (1) nitrate of soda, (2) salt cake, (3) witherite (barium carbonate), and (4) zinc oxide. For Part X see *Ceram. Abs.*, **12** [3], 101 (1933). G.R.S.

Some temperature measurements on wired glass. H. E. BECKETT. Presented at the Dec. meeting of the Society of Glass Technology. Abstracted in *Glass*, **10** [1], 21 (1933). G.R.S.

Testing safety glass. M. NICOLARDOT. *Glaces et Verres*, **5** [25], 4–6 (1932); abstracted in *Keram. i Steklo*, **8** [10], 40 (1932).—Tests were made on the (1) transparency of "triplex" glass, (2) action of light on the change in color of the elastic intermediate layer, (3) action of sudden changes of temperature, (4) action of long heating, and (5) influence of repeated shaking. The results are tabulated. N. points out that the lack of change in color after long exposure to ultra-violet rays is due to the fact that cellulose has been replaced by acetate of cellulose. M.V.K.

Character, importance, and requirements of safety glass. C. H. ZEFER. *Glashütte*, **62** [34], 590–93; [39], 678–79; [40], 694–96 (1932).—Z. gives a general review of the manufacture and testing of safety glass. M.V.K.

Soldering glass tubes. M. A. BESBORODOV. *Keram. i Steklo*, **8** [10], 33–35 (1932).—A number of glass tubes having different coefficients of expansion were soldered together. The strength of the soldering was determined by investigating the thermal resistance of the soldered tubes. All the soldered glasses were annealed and observed in a polarizing apparatus. No stresses were observed and there was no regularity in the relation between the difference of the coefficients of expansion and the strength of the soldering. It has been determined that soldering is not a function of the coefficients of expansion only (for low temperatures) of soldered glasses. M.V.K.

Normalization of laboratory glassware. CH. LORMAND. *Ann. chim. anal. chim. appl.*, **14**, 481–87 (1932).—Specifications are given for the size and shape of the important apparatus used in analytical operations. (*C.A.*)

Effect of age on the strength of commercial glassware. J. B. MURGATROYD. *Pottery Gaz.*, **57** [661], 880 (1932); for abstract see *Ceram. Abs.*, **12** [2], 56 (1933). E.J.V.

Volumetric glassware. ANON. *Laboratory*, **5** [3], 38–40 (1932).—Volumetric glassware is being made, the graduations and numbers of which are filled with a blue enamel. Illustrated. F.G.H.

Perfected method and means for producing domestic glass silk. ANON. *Amer. Glass Rev.*, **52** [19], 10 (1933). E.P.R.

Glass blackboards. ANON. *Popular Sci. Monthly*, **121** [3], 22 (1932).—Illustrated. See also *Ceram. Abs.*, **11** [6], 361; [7], 409 (1932). F.G.H.

Filamentless glass bulb in radio industry. ANON. *Amer. Glass Rev.*, **52** [16], 10 (1933). E.P.R.

Modern glass in new Roxy Theater. MADELINE LOVE. *Amer. Glass Rev.*, **52** [16], 21–23 (1933).—A detailed description of the outstanding effects in glass is given. E.P.R.

Vacuum glass brick cut heat loss. ANON. *Popular Sci. Monthly*, **121** [6], 26 (1932).—Windows made of glass brick feature the new Long Island Park Commission building recently completed at Sunken Meadow, N. Y. Illustrated. F.G.H.

Windowless operating room uses glass. ANON. *Amer. Glass Rev.*, **52** [17], 18 (1933). E.P.R.

Old English glasses. No. 38. Tall flint glass brimmer. F. BUCKLEY. *Glass*, **10** [1], 14–15 (1933).—A description is given of a tall cylindrical water glass, holding about a quart of liquid. It was made about 1700 and was probably imported from

Germany. Comparison is made with three German brimmers. Photographs of all four glasses are shown. For No. 37 see *Ceram. Abs.*, **12** [3], 102 (1933). G.R.S.

Glass and alchemy. VAL. CORDIER. *Glaces et Verres*, **6** [31], 10–13 (1932).—The significance of the researches of alchemists on glass is discussed. Glass was considered a metal by the Ancients, particularly the Egyptians. The composition of an eye made of glass found in the sarcophagus of the Princess Khumumuit (2000 B.C.) is given. M.V.K.

Book Reviews

The Fabrication and Decorative Fashioning of Glass. (Le Travail et Le Façonnage Decoratif du Verre.) JACQUES WOLF. Published by L'Edition Universelle, S.A., 53 Rue Royale, Bruxelles. 411 pp. Price 65 F. The many processes used in the shaping and decoration of glass are explained clearly and briefly. The book does not give much in the way of details of furnaces and plant layouts. It covers the materials used for colors and for the glass batches in rather complete form. Used by the arts and crafts worker, this volume should be helpful. It has enough material on the compositions of the batches and the properties of the resulting glasses to serve as a guide for the further processing incident to decorative processes. The book is quite complete in its descriptions of the processes, formulas, and mechanical tools used in the embellishment of glass.

A brief history of the work of the various nations is presented and the many processes used by these nations are explained. For all processes described there is a satisfactory presentation of the recipes so that the amateur or the professional may work with certainty. Colors in the glass, treatments on the surface, acid etching, engraving, cutting processes of all sorts, sandblast work, metal coating, and the making of mirrors are all treated in a manner that makes each operation perfectly clear and yet is described in the fewest possible words. Mosaics are explained in somewhat greater detail than are some other processes. To an American familiar with the generous explanations in the catalogs of the grinding wheel companies, the material covering the mounting of these wheels in this volume seems unnecessary. However, the book is intended for Europeans and even in America the data may be useful to teachers and crafts workers. The illustrations are well chosen and are abundant. Diagrams predominate though a dozen photogravures show factory procedure. A bibliography indicates the sources of material. The book has little in it not available in American trade journals of the period following the World War, but it does have this material in handy form with enough added to make the book a valuable addition to a ceramist's library. The reader need not be proficient in French to glean most of the really helpful information in it. P.E.COX

Glass Manufacture. M. A. BESBORODOV AND M. F. SHUR. 242 pp. 99 illustrations. State Chemico-Technical Publishing House, Moscow, 1932. Price 4 R. The book deals with glass technology in its general aspects. It is a textbook with fifteen chapters embracing twenty-seven lessons and exercises. The material is so chosen and arranged that it allows the easy study of all aspects of glass manufacture. The sections are as follows: (1) historical review of glass manufacture, (2) glass and its properties, (3) the use of glass in daily life, technique, and science, (4) raw materials used in glass manufacture, (5) glass batches, (6) refractory materials, (7) fuels and gas producers, (8) glassmelting furnaces, (9) glassmelting, (10) glassmaking by hand and by machinery, (11) annealing, (12) the mechanical treatment of glass, (13) the thermal treatment of glass, (14) the chemical treatment of glass, and (15) the present state of the glass industry in the U.S.S.R. The contents are up to date. Written by experienced teachers and glass technologists, it may be heartily recommended as a standard manual on glass technology for technical schools and for self-education. (*J.S.G.T.*)

Raw Materials for Glass Manufacture. M. F. SHUR. 79 pp. State Chemico-Technical Publishing House, Moscow, 1932. Price 1 R. This book is the first published in the U.S.S.R. devoted to the subject. It deals with the following groups of raw materials: (1) glassforming materials (in addition to the chemically prepared materials special attention is given to silicate minerals such as nepheline and nepheline syenites, trachytes, volcanic ash, and metallurgical slags), (2) coloring agents, (3) opacifying agents, (4) decolorizing agents, and (5) fining agents. An appendix contains a table of the most important substances used in glass manufacture and their chief properties. The book reflects the research work carried out in the U.S.S.R. for the last few years on the use of new kinds of raw materials in the glass industry. (*J.S.G.T.*)

Glass Melting Pot Furnaces. S. S. BERMAN. 61 pp. 44 illustrations. State Chemico-Technical Publishing House, Moscow, 1932. Price 55 kopeks. This small, well-illustrated brochure, written in popular languages, gives in concise but clear form an account of the construction and operation of the chief types of glassmelting pot furnaces. (*J.S.G.T.*)

Manufacture of Mirrors. L. PORTNOV. 91 pp. 122 illustrations. State Chemico-Technical Publishing House, Moscow, 1932. Price 1 R. In the nineteen chapters there is given a detailed description of the manufacture of mirrors, and the different grades of glass used for this purpose are discussed. (*J.S.G.T.*)

PATENTS

Apparatus for drawing tubular articles. GASTON DELPECH (Société Quartz et Silice). U. S. 1,894,853, Jan. 17, 1933.

Leer feeding device. JOHN MAYO. U. S. 1,894,881, Jan. 17, 1933.

Glassblowing machine. L. D. SOUBIER (Owens-Illinois Glass Co.). U. S. 1,895,137 and 1,895,139, Jan. 24, 1933.

Glassware forming machine. L. D. SOUBIER (Owens-Illinois Glass Co.). U. S. 1,895,138, Jan. 24, 1933.

Apparatus for manufacturing plate glass blanks and the article produced thereby. W. H. ALLISON (Libbey-Owens-Ford Glass Co.). U. S. 1,895,362, Jan. 24, 1933.

Process for producing plate glass. W. H. ALLISON (Libbey-Owens-Ford Glass Co.). U. S. 1,895,363, Jan. 24, 1933.

Method and apparatus for producing sheet glass. J. C. BLAIR (Libbey-Owens-Ford Glass Co.). U. S. 1,895,365, Jan. 24, 1933. CARROLL CONE (Libbey-Owens-Ford Glass Co.). U. S. 1,895,916, Jan. 31, 1933.

Method and apparatus for reducing a sheet to thickness. J. C. BLAIR (Libbey-Owens-Ford Glass Co.). U. S. 1,895,405, Jan. 24, 1933.

Apparatus for annealing glass. HENRY LEBEL (Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey). U. S. 1,895,547, Jan. 31, 1933.

Method and apparatus for tempering glass sheets. HENRY LEBEL (Soc. anon. des manufactures des glaces et produits chimiques de St.-Gobain, Chauny, et Cirey). U. S. 1,895,548, Jan. 31, 1933.

Method and apparatus for cross cutting wire glass. GEORGE AURIEN AND P. F. GUTMANN (Mississippi Glass Co.). U. S. 1,895,779, Jan. 31, 1933.

Transfer apparatus for glassware. THOMAS STENHOUSE (Hazel-Atlas Glass Co.). U. S. 1,895,824, Jan. 31, 1933.

Process for surfacing sheet glass. J. C. BLAIR (Libbey-Owens-Ford Glass Co.). U. S. 1,895,908, Jan. 31, 1933.

Means for washing and cleaning glass sheets. T. J. LEYLAND (Libbey-Owens-Ford Glass Co.). U. S. 1,895,934, Jan. 31, 1933.

Stem and method and means for making. J. A. SPENCER (Raytheon Production Corp.). U. S. 1,896,599, Feb. 7, 1933.

Conveying mechanism for glassware, etc. R. G. BACHELLER (Hartford-Empire Co.). U. S. 1,896,657, Feb. 7, 1933.

Method and apparatus for manufacture of blown glassware. A. J. SMITH (Hartford-Empire Co.). U. S. 1,896,870, Feb. 7, 1933.

Glassware annealing leer and drift controlling apparatus therefor. H. A. WADMAN (Hartford-Empire Co.). U. S. 1,896,874, Feb. 7, 1933.

Method and apparatus for working fused silica. G. A. MILLAR (General Electric Vapor Lamp Co.). U. S. 1,897,487, Feb. 14, 1933.

Glassworking machinery. G. A. MILLAR (General Electric Vapor Lamp Co.). U. S. 1,897,488, Feb. 14, 1933.

Method and apparatus for producing vitreous articles. G. A. MILLAR (General Electric Vapor Lamp Co.). U. S. 1,897,489, Feb. 14, 1933.

Apparatus for working fused silica. G. A. MILLAR (General Electric Vapor Lamp Co.). U. S. 1,897,640, Feb. 14, 1933.

Apparatus for producing laminated glass. J. W. H. RANDALL (Libbey-Owens-Ford Glass Co.). U. S. 1,897,862, Feb. 14, 1933.

Method and apparatus for melting glass. H. A. WADMAN (Hartford-Empire Co.). U. S. 1,897,973, Feb. 14, 1933.

Machines for producing hollow glassware. O. EVANS (Europäischer Verband der Flaschenfabriken Ges.). Brit. 385,683, Jan. 11, 1933.

Glassware forming machines. W. W. TRIGGS (Europäischer Verband der Flaschenfabriken Ges.). Brit. 385,767, Jan. 11, 1933.

Manufacture of sheet glass. A. E. EDWARDS (Naamlooze Vennootschap Mij. tot Beheer en Exploitatie van Octrooien). Brit. 385,775, Jan. 11, 1933.

Apparatus for severing a charge of glass below a suction mold in glassware-forming machines. W. W. TRIGGS (Europäischer Verband der Flaschenfabriken Ges.). Brit. 385,827, Jan. 11, 1933.

Apparatus for hardening glass. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Brit. 385,843, Jan. 11, 1933.

Automatic machines for making glassware. LYNCH CORP. Brit. 386,012, Jan. 18, 1933.

Means for transferring articles from one conveyer to another. SIMPLEX ENGINEERING CO. AND J. SYLVESTER. Brit. 386,467, Jan. 25, 1933.

Leer stackers. E. F. ANGER AND STANDARD BOTTLE CO., LTD. Brit. 386,488, Jan. 25, 1933.

Drying of glassmelting pots and other articles made from plastic material. HERZOGENRATHER GLASWERKE BICHEROUX ET CIE, GES. Brit. 386,819, Feb. 1, 1933.

Process and apparatus for continuous manufacture of sheet glass, either plain or with any impressed pattern. SOC. ANON DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE ST.-GOBAIN, CHAUNY, ET CIREY. Brit. 386,910, Feb. 1, 1933.

Glass furnaces. JOHN MONCRIEFF, LTD., AND ALEXANDER FRANCIS MCNISH. Fr. 730,194, Jan. 19, 1932. Means for circulating the glass in the discharge basins are described. (*C.A.*)

Mirrors. MAX ERMES. Fr. 730,651, Jan. 28, 1932. Vessels are described for pouring the Ag solution and the reducing solution simultaneously onto the glass, the solutions receiving a preliminary mixing as they flow. (*C.A.*)

Glass. HARTFORD-EMPIRE CO. Fr. 730,662, Jan. 28, 1932. Means for controlling the flow of glass are described. (*C.A.*)

Annealing furnace for glass. THÉODOR A. BEHR AND BROWN, BOVERI & CIE. Fr. 730,677, Jan. 29, 1932. (*C.A.*)

Safety glass. SOC. ANON. POUR LES CRÉDITS IMMOBILIERS ET COMMERCIAUX. Fr. 732,405, Feb. 27, 1932. Glass which is resistant to high pressure and shock is made by binding together 2 or more relatively thick sheets of glass by an intermediate layer of synthetic resin or cellulose derivatives. (*C.A.*)

Apparatus for tempering glass. COMPAGNIES RÉUNIES DES GLACES ET VERRES SPÉCIAUX DU NORD DE LA FRANCE. Fr. 732,898, March 9, 1932. (*C.A.*)

Production of U.-V. transmitting glass. DEUTSCHE SPIEGELGLAS A.-G. Ger. 493,857, Dec. 30, 1925. The glass batch containing as little iron oxide as possible also contains a few tenths of one per cent of stannous chloride. A little cobalt oxide can also be employed. (*J.S.G.T.*)

Spinning glass threads. W. ROSSLER. Ger. 526,900, March 25, 1928. In order to draw hollow threads the glass is allowed to flow over ring-shaped nozzles the bore of which communicates with the atmosphere by means of suitably disposed ducts. (*J.S.G.T.*)

Production of glass threads. NAAMLOOZE VENNOOTSCHAP MIJ. TOT BEHEER EN EXPLOITATIE VAN OCTROOIEN. Ger. 539,738, Nov. 30, 1930. The molten material flows in a thin continuous stream onto a fast rotating disk from which it is flung off in the form of a fine thread. (*J.S.G.T.*)

Cutting sheets of glass by hot wires. PITTSBURGH PLATE GLASS CO. Ger. 541,271, Dec. 28, 1929. (*J.S.G.T.*)

Molding the ends of tubes to form bottle necks. J. DICHTER. Ger. 541,304, June 24, 1928. (*J.S.G.T.*)

Gathering mold charges. H. SEVERIN. Ger. 542,547, May 21, 1927. The various arms of a multi-arm rotating glassforming machine are moved radially into the furnace or forehearth for the purpose of gathering the charge of glass. (*J.S.G.T.*)

Pressing several articles at once. BARTSCH, QUILITZ A.-G. Ger. 542,548, June 29, 1930. (*J.S.G.T.*)

Drawing glass tube or cane. R. SOLOMON. Ger. 542,549, Sept. 27, 1928. (*J.S.G.T.*)

Grinding and polishing continuously produced sheet glass. PILKINGTON BROS., LTD. Ger. 543,401, Jan. 13, 1927. (*J.S.G.T.*)

Gathering mold charges. SOC. ANON. D'ÉTUDES ET DE CONSTRUCTIONS D'APPAREILS MÉCANIQUES POUR LA VERRERIE. Ger. 543,606, May 22, 1930. A continuously rotating table is caused to have substantially zero motion relative to the glass feeding it by causing the platform on which the machine turns to oscillate in the required sense. (*J.S.G.T.*)

Fire-polishing machine. GLASFABRIK A.-G. Ger. 543,763, Dec. 12, 1929. The opening for the burner is toward the top of the circular section tunnel through which the glass (particularly pressed glass) is passed so that the flames are given a whirling motion and lick both tops and bottoms of the articles. (*J.S.G.T.*)

Machine production of bottles with push-up bottoms. SOC. ANON. D'ÉTUDES ET DE

CONSTRUCTIONS D'APPAREILS MÉCANIQUES POUR LA VERRERIE. Ger. 543,833, April 23, 1930. After blowing the bottle in the finishing mold with a flat bottom, the bottom plate of the mold is lowered so that the bottle bottom softens again and a specially shaped bottom plate is then pushed up against it to give the required form. (*J.S.G.T.*)

Cutting continuously produced wired sheet glass. MISSISSIPPI GLASS CO. Ger. 543,834, April 24, 1930. (*J.S.G.T.*)

Drawing sheet glass. B. ENGELS. Ger. 544,414, Nov. 8, 1930. (*J.S.G.T.*)

Take-out device. HARTFORD-EMPIRE CO. Ger. 544,925, July 12, 1927. (*J.S.G.T.*)

Cutting glass tubes into lengths. F. MEYER. Ger. 545,289, Sept. 9, 1928. (*J.S.G.T.*)

Continuous grading and feeding of abrasive material. PILKINGTON BROS., LTD. Ger. 545,560, June 27, 1930. (*J.S.G.T.*)

Casting and rolling sheet glass. H. NOWOTNY. Ger. 546,064, Sept. 20, 1929. (*J.S.G.T.*)

Maintaining level in forehearths. SOC. ANON. D'ÉTUDES ET DE CONSTRUCTIONS D'APPAREILS MÉCANIQUES POUR LA VERRERIE. Ger. 546,087, July 15, 1930. Several members rotating about vertical axes are so fitted in the forehearth that they drive glass to the front and effectually seal the space at the sides and bottom of the forehearth so that the glass is maintained at a given height in the latter independent of that in the furnace. Excess glass can flow back to the furnace over the top of the rotating members. (*J.S.G.T.*)

Pipe for glassblowers. A.-G. PRIS. Ger. 546,088, April 17, 1930. In a device wherein air is sucked into a hand pump and then used to blow out a parison on the end of the pipe to which the pump is attached, a spring is incorporated in the pump so that the blowing is carried out under constant pressure. (*J.S.G.T.*)

Forming glassware out of tubing. J. DICHTER. Ger. 546,089, Nov. 28, 1930. (*J.S.G.T.*)

Arrangement of leer belt. UNITED GLASS BOTTLE MANUFACTURERS, LTD. Ger. 546,091, Aug. 7, 1929. The upper surface of the flexible metal belt is supported on rollers suitably placed along the leer and the lower or return side of the belt is maintained in contact with these rollers, *e.g.*, by running over other rollers suitably disposed below it. (*J.S.G.T.*)

Continuous tank furnace for melting glass. H. KNOBLAUCH. Ger. 546,170, March 22, 1930. In order to remove dense, inhomogeneous glass from the bottom of the furnace, the bottom is sloped down toward the filling end and a bridge-like member is provided so that the bad glass passes underneath it into a chamber behind the filling position, whence it is removed when necessary. (*J.S.G.T.*)

Delivering glass to rolling plant. E. HILGER. Ger. 546,171, June 13, 1929. (*J.S.G.T.*)

Production of glass plates. PATENT-TREUHAND-GES. FÜR ELEKTRISCHE GLÜHLAMPEN M. B. H. Ger. 546,172, Nov. 25, 1930. The glass softened by heat to a suitable plasticity is dropped into the mold and is drawn in to the edges thereof by suction applied through fine ducts suitably disposed. (*J.S.G.T.*)

Melting quartz glass *in vacuo*. ALLGEMEINE ELEKTRICITÄTS-GES. Ger. 546,442, March 24, 1931. Tubes are provided in the neighborhood of the melting zone through which the air and gas evolved during melting are sucked off. (*J.S.G.T.*)

Grinding and polishing sheet glass. P. DRYON. Ger. 546,479, March 31, 1929. (*J.S.G.T.*)

Production of hollow glassware. NAAMLOOZE VENNOOTSCHAP INTERNATIONAL OCTROOIBUREAU. Ger. 546,573, May 6, 1925. In a machine in which the blown ware is removed from the mold by a device which grips it around the neck, the body is cut away from the neck portion by a melting-off device without causing the walls to fall together at the point of melting off. (*J.S.G.T.*)

Feeding a continuously rotating forming machine. H. SEVERIN. Ger. 547,134, Nov. 26, 1929. Means are provided for oscillating the molds of a continuously rotating machine so that at the moment of receiving their charge of glass they are at rest with respect to its direction of fall. (*J.S.G.T.*)

Operating molds of glassblowing machine. A. MEDER. Ger. 547,295, Oct. 13, 1927. In a device for opening and closing the half molds by means of a hand wheel, the halves are actuated by means of weights or other pressure devices. (*J.S.G.T.*)

Production of glass tube and cane. FIRMA J. RIEDEL. Ger. 547,751, June 18, 1930. (*J.S.G.T.*)

Glass. GEORG JAECKEL (Sendlinger optische Glaswerke G.m.b.H.). Ger. 557,136, Nov. 23, 1929. In the manufacture of colorless glass, contamination of the melt by coloring impurities derived from the melting pot, tank, etc., is avoided by adding to the pot, etc., in the course of its manufacture, a physical or chemical decolorizing agent in an amount corresponding to the amount of coloring impurity contained in the refractory material from which the pot, etc., is made. Thus, 0.25% of NiO may be added to chamotte containing 2% of Fe_2O_3, before making a pot therefrom. See also *Ceram. Abs.*, **11** [10], 524 (1932). (*C.A.*)

Safety glass. RICHARD SPRINGER (Allgemeine Elektricitäts-Ges.). Ger. 557,165, June 30, 1929. Two layers of glass are united by an intermediate layer of a condensation product of the glycerolphthalic anhydride type. (*C.A.*)

Uniting quartz or glass with metal. MARCELLO PIRANI AND ADOLF FEHSE (Patent-Treuhand-Ges für elek. Glühlampen m.b.H.). Ger. 557,205, July 1, 1931. A piece which varies gradually in composition from pure quartz or glass at one end to pure metal at the other is prepared by sintering together in a mold a number of superimposed layers prepared from powdered quartz or glass and powdered metal. One end of the piece is then united to the quartz or glass article and the other end to the metal article. (*C.A.*)

Nozzle for making endless wired glass strips. RUDOLF LANGREHR. Ger. 558,497, Oct. 13, 1931. (*C.A.*)

Structural Clay Products

Tentative specifications for clay sewer pipe. ANON. *Proc. A.S.T.M.*, **32** [Part I], 724–35 (1932).—These specifications cover clay products intended to be used for the conveyance of sewage, industrial wastes, and storm water. This is a tentative standard and will supersede the present standard when adopted. R.A.H.

Standard size brick. ANON. *Clay Prod. News*, **6** [1], 10 (1933).—A committee is being appointed to select a standard size brick for Canada. It is expected that the one adopted will be larger than that used in the U. S. W.W.M.

Manufacture and use of refractory materials. Report of Refractory Materials Subcommittee of the Institution of Gas Engineers and the Society of British Gas Industries. *Gas World*, **97**, 403, 466 (1932).—Progress of research on gas-plant refractories, including retort patching, and the permeability of refractories and their disintegration by the action of CO is discussed. (*C.A.*)

Raw materials for brick and tile. II. Firing in periodic furnaces. ALIX CORNILLE. *Rev. mat. constr. trav. pub.*, No. 279, pp. 229–32*B* (1932).—C. analyzes the best raw materials used for manufacturing brick and tile in France and describes the charging and firing of several types of periodic furnaces. For Part I see *Ceram. Abs.*, **12** [3], 107 (1933). M.V.K.

Harmful material in brick clay. A. PELLACINI. *Corriere ceram.*, **13** [11], 405–11 (1932).—The action of the principal impurities found in clay is explained. M.V.K.

Brickmaking in England. R. BARTA. *Stavivo*, p. 160 (1931).—The characteristic features of the brickmaking industry in Great Britain are outlined, particularly where they differ from Czechoslovakian conditions. Mention is made of London stocks, sand-faced, rustic, multicolored, Fletton brick, etc. (*Trans. Ceram. Soc.* [Eng.])

Effect of prolonged storage on ground fireclay sewer pipe body. J. O. EVERHART. *Ceram. Age*, **20** [6], 218–19 (1932); for abstract see *Ceram. Abs.*, **11** [12], 615 (1932). R.G.M.

Ceramics and the machine-made house. G. A. BOLE. *Ceram. Age*, **20** [5], 183–200 (1932); see also *Ceram. Abs.*, **12** [1], 38 (1933). R.G.M.

Book Reviews

Weathering of Natural Building Stones. R. J. SCHAFFER. Building Research *Special Rept.*, No. 18. x + 149 pp. H. M. Stationery Office, London, 1932. 4s 6d. This is a carefully made compilation of previously published work on the effect of weather on natural building stones. There are sections on defects due to unskilful selection, faulty craftsmanship, physical and chemical phenomena, soluble salts, and living organisms. Several preventive and remedial measures are described and several methods of testing stones with a view to estimating their durability are included. The efflorescence on stone and brickwork caused by soluble salts is discussed and some instances of decay due to this cause are described and illustrated. The decay at the Houses of Parliament

as well as in Bristol, York Minister, and elsewhere is briefly described and some useful comments are included, but very little information is given as to how the decay of building stones in large industrial areas is to be prevented. Careful and skilled selection with ample tests of the available materials is obviously needed, but even these can not be fully relied upon. Durability can not be obtained by any method of treating the stone either before or after erection. There appears to be little hope of the discovery of a satisfactory preservative for stonework and the Research Board is unable at present to recommend any method of preservation as likely to be permanent. A warning is given against the use of any substances other than water or steam for cleaning old stone buildings, and the use of soda, other alkalis, and acids is strongly condemned. Some useful hints on restoring decayed structures are included. (*Chem. & Ind.*)

Clay Industry Calendar, 1933. Vol. I. Notebook calendar and 18 pp. text. **Vol. II.** Technical part, 304 pp. 3.30 M. Published by Tonindustrie-Zeitung, Berlin. For many years this calendar has been devoted to the manufacturers of building materials and has served as a reference to the clay and building industries. The 1933 edition is written for the demands of the practice. The main contribution in the technical volume is given by the review "From the field of brick manufacture." A selection of important manufacturing problems is treated on 62 pages, describing, especially, the prevailing difficulties. This review is presented under the following headings: clay winning, selection of clay-preparing machinery, stiff-mud process, dry-press process, troubles due to forming, brick drying, setting, water-smoking, firing, stoking, glazing, lime in clay, scumming, and efflorescence. Though it is impossible to fully discuss all details of manufacture, nevertheless this treatise offers a number of useful suggestions for every factory. A reference to literature is added. The index will help to locate any desired information. A section deals with legal protection, and numerous tables with data pertaining to wall thicknesses, masonry loadings, weights of building materials and building elements, comparison of properties and costs of various kinds of brick and of brick walls, classification of lime and cement, cement standards in Germany, data of performance of some clay excavators, power consumptions and efficiency of ball mills, heat value of some fuels, fuel consumption of various types of kilns, etc., are included. Like previous calendars, there is a bibliography and a list of supply houses. The calendar, with tables of general interest, is presented in the other volume. T.W.GARVE

PATENTS

Process for surface treating brick and brick made thereby. C. F. TEFFT (Claycraft Mining & Brick Co.). U. S. 1,896,126, Feb. 7, 1933.

Masonry facing construction. V. E. SHANKLIN. U. S. 1,896,188, Feb. 7, 1933.

Building construction. V. W. NOONAN. U. S. 1,896,325, Feb. 7, 1933.

Building block and wall construction. W. G. DEMAREST. U. S. 1,896,770, Feb. 7, 1933.

Method of producing a cellular clay body. TAJAMUL HUSAIN AND G. A. BOLE (Cellular Clay Corp.). U. S. 1,897,667, Feb. 14, 1933. In a process for producing a cellular fired clay product, the step consists in generating and releasing a gas in a clay slip of fluid consistency by the interaction of an acid and a carbonate added to the slip.

Road and building materials, electric insulation materials, etc. H. V. GRÖNROOS. Brit. 383,722, Nov. 30, 1932.

Building with brick and mortar, etc. E. LUX. Brit. 385,698, Jan. 11, 1933.

Refractories

Theory of spalling. F. W. PRESTON. *Jour. Amer. Ceram. Soc.*, **16** [3], 131–33 (1933).

Theory of transforming quartz into cristobalite. A. N. SHCHUKAREV. *Jour. Gen. Chem.* (*U.S.S.R.*), **2**, 231–37 (1932).—Quartz crystallizes in the hexagonal system of the following lattice dimensions: Si–O = 1.55 Å; Si–Si = 3.03 Å; O–O = 2.55 Å. Cristobalite is of the diamond structure of the following lattice dimensions: Si–O = 1.541 Å; Si–Si = 3.08 Å. The transformation is therefore accompanied by a change in the volume which is used as a basis for studying the kinetics of the change. The reaction constant shows that the transformation is not of the first, second, or third order. By van't Hoff's method the expression $dC/dt = K_n C^n$ is derived. K calculated for $n = 1.8$ is constant for all values of C. It is also shown that K might vary up to 2.2. A

theory is proposed that the quartz used in the experimental work consists of a mixture of different grades, therefore having different velocities of transformation. (*C.A.*)

Refractories in 1932. ANON. Excerpt from Iron and Steel Division Progress Report presented before A.S.M.E., December, 1932. *Heat Treating & Forging*, **19** [1], 16 (1933).—The properties and uses of high-alumina brick as a refractory are listed. The commercial high-alumina brick contain 50, 60, 70, and 80% alumina. Such brick are more refractory than fireclay brick. They offer greater resistance to slag erosion of certain types. They do not vitrify at as low temperatures as do fireclay brick and hence are more resistant to spalling. They have high strengths at high-temperature ranges. High-alumina brick find important uses in the steel industry in blast-furnace stoves, open-hearth checkers, and water-cooled ports. In the steam-power field they are used for the side and bridge walls of boiler settings to resist certain types of slags. They are used in the settings of high-temperature cracking units in the oil-refining industry because they resist the alkaline ash from fuel oil better than fireclay brick. In the glass industry they are used in the ports and checkers of glass tanks. J.L.G.

Refractories and the nonferrous metal industry. FRANK S. RUSSEL. *Metal Ind.* [London], **42** [2], 57–58 (1933).—Progress in the refractory industry is discussed. M.V.K.

Silicon carbide for distilling columns. ANON. *Laboratory*, **5** [2], 26 (1932).—Silicon carbide has been found to be a good inexpensive material for use as a filler in distilling columns. Particles with sharp points are desirable. F.G.H.

Fused alumina as a refractory (Sinterkorund). ANON. *Ind. chimique*, **19** [226], 866 (1932); for abstract see *Ceram. Abs.*, **11** [10], 530 (1932). M.V.K.

Glass pot. I. Forming and drying behavior of raw materials and bodies. SEIJI KONDO AND MASANOBU NAKATSUJI. *Jour. Jap. Ceram. Assn.*, **39** [460], 213–17 (1931).—Nearly definite relations were found between forming and drying properties for most of the raw materials of a glass pot. That the additive law can be applied to the mixtures of a Kibushi clay, a Gairome kaolin, and a grog was confirmed for drying shrinkage and the water of formation. **II. Firing behavior of raw materials and bodies.** *Ibid.*, **39** [461], 294–303 (1931).—Promising bodies have been found within the ranges of (1) the Gairome kaolin 70 to 55% and the grog 30 to 45%, and (2) the Gairome kaolin and the Kibushi clay 70 to 50% and the grog 30 to 50%. Their drying and firing properties are compared to those of 5 commercial bodies. **III. Thermal expansion of raw materials and bodies.** *Ibid.*, **39** [464], 506–15 (1931).—Rods made of the raw materials of a glass pot, their mixtures, commercial glass pot bodies including those made of protecting tubes for thermocouples, rods for stirring molten metals, and electric furnace refractories were fired to cones 14 to 13.5, and their thermal expansions were measured up to about 1200°C. The temperatures at which the rods began to shrink or attain maximum expansion were 1017 to 1150°C. It was observed that the thermal expansions of some clays can not be presumed from their chemical or physical properties. S.K.

Study of the permeability and porosity of refractories. ANON. *Chim. & ind.*, **28** [4], 989–90 (1932).—A discussion of the investigations of Robert Hadfield and R. J. Sarjant (*Ceram. Abs.*, **12** [2], 64 (1933)) is given. It was found that there was no definite relationship between porosity and permeability in the case of refractory clays or silica. A diatomite insulating material having a 70% porosity possesses a low permeability. The continuity of the system of pores is the essential factor and it is regulated by the shape of the grain and the sorting of the raw materials. Generally, the permeability decreases when the temperature rises. M.V.K.

Load test of refractories. III. Considerations on the testing method and study of Oya and Hamazumi stone. MINORU NAKAMOTO. *Jour. Jap. Ceram. Assn.*, **39** [459], 159–69 (1931).—Descriptions are given of the measurement of temperature and the calibration of the recorder of the testing apparatus, and results of accurate determinations on the softening behavior of the two architectural stones are reported. S.K.

Retarding the slaking of basic refractories. MASAJI KAJIWARA. *Jour. Jap. Ceram. Assn.*, **39** [461], 313–15 (1931).—Magnesia brick were exposed to mixtures of steam and combustion gases under 1 atmospheric pressure. Brick thus treated are more resistive to the action of high pressure steam than the untreated ones. Surfaces of the treated brick are probably covered with crystalline $MgCO_3$ and $Mg(OH)_2$. S.K.

Study of grog refractories. II. Comparative tests of refractories made under different conditions. SHOICHIRO NAGAI AND AKITARO MANNAMI. *Jour. Jap. Ceram. Assn.*, **39** [458], 103–109 (1931).—The influences of the forming pressure, proportion of the raw materials, and firing temperature upon cold or hot compressive strength, porosity, etc., of the refractories have been sought. **III.** *Ibid.*, **39** [462], 363–68 (1931).—

Tests were made on absorption, porosity, specific gravity, etc., of grog refractories before and after heating them at 1300°C for 30 min. under a load of 10 kg./sq. cm. S.K.

Super refractory. CORUNDITE REFRACTORIES. *Blast Fur. Steel Plant*, **21** [2], 123 (1933).—Corundite LW-10 is a new super-refractory high aluminous insulating brick that can be used to replace fire brick in the majority of instances where operating temperatures up to 2600°F are maintained and no fluxing agents are present in the atmosphere. E.J.V.

D-process for manufacturing highly refractory products. CARL GROYEN. *Feuerfest*, **8** [9], 132 (1932).—To produce a highly resistant and refractory product it is necessary that the flux be intimately combined with the bonding agent; this can be obtained only when the former is not completely dead-burned and is chemically active. According to the D-process, the thinning or fluxing agent is fired in a special manner, granulated, and combined with the bonding agent. Because of the chemical activity and hydraulic properties of the thinning agent, the products show a greater hardness after drying, and the formation of hair cracks and blisters from drying or firing is avoided. Further advantages of the D-process are lower consumption of fuel and shorter firing time. M.V.K.

Highly refractory special materials for high temperatures. GALLUS. *Wärme*, **55** [38], 644–46 (1932); abstracted in *Feuerfest*, **8** [11], 172 (1932).—G. discusses the reasons for utilizing refractory special materials such as corundum, silicon carbide, magnesite, zirconium silicate, chromium ore, sillimanite, carbon, alumina, zirconia, thoria, beryllia, and boron nitride. M.V.K.

Characteristics of some special refractory products. I. MARCEL LÉPINGLE. *Rev. mat. constr. trav. pub.*, No. 279, pp. 225–28 (1932).—Refractories may be classified into three groups, (1) ordinary silico-aluminous refractories, (2) extra-aluminous refractories, and (3) special refractories. The second group contains refractories whose main constituent is natural silicate of aluminum with ball clay as bonding agent. These refractories are characterized by their high refractoriness and mechanical resistance and their great resistance to erosion and fluxes. Refractories containing bauxite or corundum, whose main constituent is fused alumina, have a softening temperature under load reaching 1700°, their fusing temperature is 1900 to 1950°, and they have a high resistance to pressure and a slight variation in linear dimensions but are sensitive to sudden changes of temperature. They are used in gas and liquid fuel burning furnaces. Silicon carbide refractories can be used only in a reducing atmosphere, and their softening temperature depends on the amount of clay used as bonding agent. Such products are highly resistant to changes in temperature and are used in oil furnaces. They are resistant to erosion and abrasion and are characterized by the constancy of their linear dimensions. Zirconium refractories have a remarkable chemical passivity and are therefore mostly used in the chemical and metallurgical industries. Different English, French, Belgian, and German refractories are compared briefly and the qualities of five different Belgian refractory products are discussed. M.V.K.

"Hydrecon," a hydraulic refractory concrete. J. H. FRANCE REFRACTORIES CO. *Power*, **76** [1], 49 (1932).—This material is claimed to have a low coefficient of heat transfer, resistance to spalling from sudden thermal changes, and low coefficient of expansion, and forms a monolithic refractory lining for boiler furnaces, checker chambers, kilns, furnaces, and oil stills. F.G.H.

New developments in crown of Martin furnace. E. MAASE. *Feuerfest*, **8** [12], 177–78 (1932).—M. discusses the influence of the thickness of the crown on its durability and loss of heat. Different types of crowns are described. M.V.K.

New suspended crown. PHILIPP. *Feuerfest*, **8** [11], 175 (1932).—P. describes a new type of suspended crown according to Reintjes. M.V.K.

Refractory brick. G. MILANI. *Corriere ceram.*, **13** [5], 183–87; [6], 202–207; [7], 243–49; [8], 275–81 (1932).—M. gives the raw materials, chemical composition, manufacture, behavior and properties, tests, and uses of (1) refractory clay brick (neutral), (2) silica brick (acid), (3) magnesia brick (basic), (4) chromium brick (neutral), (5) bauxite brick (neutral), and (6) special brick for different industries. M.V.K.

Thermal conductivity of refractory brick. SEIJI KONDO AND HIROSHI YOSHIDA. *Jour. Jap. Ceram. Assn.*, **39** [466], 657–63 (1931).—The thermal conductivities of refractory brick, building brick, and an insulation brick were measured by means of a small water calorimeter. The mean conductivities at different temperatures up to about 1200°C are shown by tables and diagrams. The conductivities increase steadily with rise of temperature except in magnesia and chrome refractories. The mean conductivities in g. cal./cm./°C/sec. are shown in the following table:

Sample	Porosity (%)	Range of temperature (°C)	Mean conductivity
Grog brick	29.1	163–1223	0.00235
Agalmatolite brick	23.9	247–1223	0.00250
Silica brick	20.1	270–1200	0.00342
Highly aluminous brick (SM)	33.4	270–1120	0.00251
Chrome brick	29.3	270–1227	0.00342
Magnesia brick	21.4	219–1163	0.00474
Building brick	40.2	69– 871	0.00163
Slag brick	38.2	32– 876	0.00148
Isolite (a diatomaceous earth)	66.4	160–1092	0.00056

S.K.

Thermal expansion of refractory brick. SEIJI KONDO AND AKITARO MANNAMI. *Jour. Jap. Ceram. Assn.*, **39** [465], 576–81 (1931).—Linear expansion of Japanese refractory brick is measured by means of an electric furnace and a small comparator. The shrinking temperatures of grog, agalmatolite, and silica brick are 1153 to 1285°, 1090 to 1240°, and 1504°C, respectively, and their mean coefficients of expansion from room temperature to the shrinking temperature are 0.0546 to 0.0573, 0.0551 to 0.0566, and 0.04489, respectively. The results of experiments in which linear expansion is measured under a weak load by a special apparatus up to 1550°C are also described. S.K.

Gas permeability of fire brick and iron ores at high temperatures. I. Fire brick. YOSHIAKI TADOKORO. *Jour. Jap. Ceram. Assn.*, **40** [478], 619–37 (1932).—T. improved his arrangement for measuring the gas permeability of refractories and other materials by continued heating, and experiments have been made of 5 kinds of fire brick. The permeability u was calculated by the following formula: $u = Q/T \cdot (Pt + h)/P \cdot 273/(273 + t) \cdot 1/(Ah)$; where Q = volume of gas in cubic centimeters, T = time in seconds, Pt = atmospheric pressure in g./sq. cm., h = pressure of gas in water head in centimeters, P = normal pressure or 1033 g./sq. cm., t = room temperature in °C, and A = area of test piece in square centimeters. Chemical composition, permeability, and other physical properties are shown in Tables I and II.

TABLE I. CHEMICAL COMPOSITION

Brick	SiO_2	Al_2O_3	Fe	FeO	Fe_2O_3	CaO	MgO	TiO_2	Cr_2O_3	Na_2O	K_2O
(*a*) Silica	92.5	1.2	0.2	0.5	2.3	2.8	0.5			0.1	0.2
(*b*) Agalmatolite	62.3	31.1			3.2	0.6	0.4	0.7		0.3	1.1
(*c*) Magnesia	7.1	2.4			6.4	1.3	82.7			0.1	0.2
(*d*) Chrome	12.0	17.2			18.1	0.4	30.0		22.1	0.4	0.1
(*e*) Grog	62.3	31.6			3.4	0.5	0.5	1.1		0.2	0.4

TABLE II. AIR PERMEABILITY AND OTHER PHYSICAL PROPERTIES

Brick	Firing temperature (cone)	P.C.E.	Specific gravity	Porosity	Permeability at 50°C	200°C	500°C	800°C
(*a*)	17	32	2.36	24.70	0.3016	0.1272	0.0839	0.0641
(*b*)	10	32	2.62	30.08	0.0256	0.0160	0.0082	0.0048
(*c*)	26	37	3.75	28.38	0.2125	0.1247	0.0654	0.0359
(*d*)	14	36	3.54	24.42	0.0694	0.0375	0.0196	0.0108
(*e*)	10	34	2.64	28.43	0.0603	0.0379	0.0196	0.0112

It is concluded that the gas permeability decreases with rise of temperature in logarithmic power though the brick expand directly as the temperature rises. The fact is contrary to the common idea that the pores open as the brick expand. S.K.

Grog brick with increased alumina content. P. P. BUDNIKOFF, A. O. BATT, A. A. GREBENIK, AND V. I. ENDOVITZKII. *Feuerfest*, **8** [11], 161–64 (1932).—Attempts to manufacture grog products having a 40% alumina content, a refractoriness of 1750° (Seger cone 34), and a deformation beginning at 1400° are described. Data on the raw materials used, the products manufactured, and methods are given. M.V.K.

Silica brick with catalyzer. B. PINÈS. *Stal.*, Nos. 3 and 4, pp. 75–83 (1931); abstracted in *Rev. Mét.*, No. 9, pp. 367–70 (1932); *Feuerfest*, **8** [11], 172 (1932).—P. describes (1) silica transformations, (2) capability of transformation of natural quartzites, (3) influence of catalyzer on the transformation, (4) the best structure of silica brick, (5) attempts to manufacture silica brick with added crystal nuclei, and (6) properties and durability of these brick. M.V.K.

Experiences with silica in a continuous vertical plant. O. A. TERNES. *Gas Jour.*, **201** [3635], 146–48 (1933).—A report is given of tests with silica refractories in the retorts and combustion chambers of a gas plant. Higher temperatures than those employed with fireclay refractories could be used, but an unusual amount of carbon was found on the surface of the retorts. Spalling of the silica refractories was a disadvantage. G.R.S.

Manufacture of magnesite brick. ANON. *Chem. Eng. Mining Rev.*, **23**, 335–36 (1931).—A deposit of magnesite near Attunga, N. S. W., is now the main source of supply in Australia. The Austrian product contains about 7% of Fe_2O_3 which lowers the temperature at which the material will sinter during calcination and acts as a bond. The Attunga magnesite with a bond of mill scale was found to make excellent brick. (*C.A.*)

Thermal conductivity of magnesite brick. GORDON B. WILKES. *Jour. Amer. Ceram. Soc.*, **16** [3], 125–30 (1933).

Effect of manufacturing process of magnesia refractories on their hydration. MASAJI KAJIWARA. *Jour. Jap. Ceram. Assn.*, **39** [463], 433–35 (1931).—A dead-burned magnesite composed of SiO_2 3.52, Al_2O_3 0.99, Fe_2O_3 5.85, CaO trace, MgO 90.52, and MnO 0.56 has been made by firing a dried slurry prepared by grinding a caustic burned magnesite and a siliceous pyrite cinder with water. The crystals of periclase are $^1/_2$ to $^1/_3$ as large as those in an Austrian product. It is far more resistant to the action of slaking, however. The effects of the fineness of the slurry, the time of storing slurry, and the rate of heating up are discussed. S.K.

Magnesite refractories. I. Microstructure of South Manchurian magnesites fired at different temperatures. SEIJI KONDO, TEIROKU SUENO, AND HIROSHI YOSHIDA. *Jour. Jap. Ceram. Assn.*, **40** [475], 422–36 (1932).—South Manchurian magnesites were heated at constant temperatures ranging from 1200 to 1800°C for 1 hr. and then examined for microstructures. (1) The chief phases observed were periclase, amorphous magnesia, forsterite, and clinoenstatite. (2) The volume per cent of olivines, spinel, and periclase calculated from the chemical compositions of the magnesites agreed well with the results of the microscopic observations. (3) The magnesites underwent marked changes at the intervals of 1200 to 1300 and 1600 to 1700°C. At 1200 to 1300°, clinoenstatite and amorphous magnesia changed almost completely to forsterite and periclase, respectively. At 1600 to 1700°, forsterite melted and filled the voids of the periclase crystals, developing the so-called poikilitic structure. (4) The more silica contained in the magnesites, the greater the rate of recrystallization. A Seizanhai magnesite mixed with various oxides was calcined at 1000°, formed into tablets, and fired to cones 26, 28, and 30 in a gas-fired kiln. The following results were obtained by observing their thin sections under a microscope: (1) The introduction of silica favored the development of forsterite and periclase crystals. (2) The addition of ferric oxide aided the development of periclase and caused the formation of minute crystals of magnesioferrite. (3) Chromic oxide seemed to dissolve in forsterite. (4) Alumina favored the development of periclase and produced a poikilitic structure, probably due to the formation of cordierite which melts at a comparatively low temperature. S.K.

Dissociation of magnesite. E. DOLLE. *Feuerfest*, **8** [11], 167–68 (1932).—Disintegration of magnesite is not monomolecular as thought by Zentnerszwer and Brusz, but proceeds from the molecules of the surface hindered by diffusion of the CO_2. Only temperatures over 550° and a definite addition of oxide accelerate the transformation of the pseudo-amorphous or amorphous state into the stable arrangement of the lattice; MgO loses the ability to absorb CO_2 molecules. All oxide additions produce a positive catalytic action which depends on the surface of the contact substance. A smaller effect has been obtained with "aged" oxides. The power of the catalyzer depends on its cohesive power and should therefore correspond with the melting point of the oxides. A thorough investigation of ferrocarbonates gave coefficients of temperature of the velocity of reaction of 1.5 to 2.0 between 315 and 350°C. The temperature of dissociation lies considerably below that of magnesite. M.V.K.

Zirconia and its use. H. TRATH. *Rev. chim. ind.*, May, 1932; abstracted in *Ind. chimique*, **19** [227], 912 (1932).—Zirconia exists in the natural state as an oxide and as a silicate. This product is especially interesting because of its infusibility (its fusing point being about 3000°), indifference to wide variations in temperature, low conductivity, and great resistance to different chemical agents. It is because of its low electrical conductivity that raw zirconia of a definite composition is used for manufacturing insulators for high-tension lines. The use of pure zirconia for the manufacture of refractories is unnecessary as minerals with a high zirconia content and an addition of a certain quantity of chemically produced zirconia are sufficient. M.V.K.

Bauxite in France. VICTOR CHARRIN. *Ind. chimique*, **19** [226], 808–11 (1932).—The use of gray bauxites for abrasives, whose average composition is 65% alumina, 6% silica, 12% iron oxide, 3% titanium oxide, and 14% water, and the manufacture of alundum are discussed. A general review of the utilization of bauxite in the French ceramic, refractory, and chemical industries and the composition of some French bauxite deposits are given. See also *Ceram. Abs.*, **11** [7], 417 (1932). M.V.K.

Bauxite in Siberia. ANON. *Ind. chimique*, **19** [227], 948 (1932).—Large deposits of bauxite have been recently discovered in the western part of Siberia. The analyses of the mineral showed the presence of 50% aluminum oxide. M.V.K.

World reserves of bauxite. C. V. *Ind. chimique*, **19** [227], 886–89 (1932).—European and American deposits of bauxite are described. M.V.K.

Uses of refractory materials in the foundry. J. G. A. SKERL. *Refrac. Jour.*, **9** [1], 19–22 (1933).—(1) Cupola linings, both of brick and rammed material, (2) coal dust, (3) blackings and plumbagos, and (4) molding sands are discussed in detail. Tables are given for comparison. E.P.R.

Refractory material in the foundry. J. MATĚJKA. *Rev. fonderie moderne*, July 19, 1932; abstracted in *Foundry*, **60** [13], 43 (1932).—A principal characteristic of refractories for foundry practice is the minimum melting point that may be tolerated. Other important qualities required include resistance to compression, expressed by the tendency of a material to become soft under the minimum pressure prevailing at the temperature of the operation, and resistance to action of flux used in the bath. The latter action takes place either by entering pores, cracks, and joints of the refractory material or by chemical action. To avoid mechanical action, a compact and well-joined material is required. Chemical action is generally avoided by glazing. The refractory usually becomes glazed in the course of use, but sometimes a glaze is added to the surface. Secondary causes of destruction of refractory linings are the actions of fuel and of gases, especially sulfurous gases. The volume of the refractory lining should remain constant, and the refractory should stand wide variations of temperature. F.G.H.

Bronze founding industry in 1932. FRANCIS W. ROWE. *Metal Ind.* [London], **42** [2], 43–46 (1933).—R. discusses the progress of the bronze founding industry with regard to furnaces and improved refractories. M.V.K.

Brackelsberg furnace. ANON. *Mech. World*, **93** [2403], 50–52 (1933).—The furnace is a cylindrical shell lined with high-grade refractory. It is rotated continuously so that there is no slag line and no excessive corrosion at one particular level. E.P.R.

Fire brick for electric furnaces. F. SOMMER. *Brit. Clayworker*, **41** [489], 328 (1933); for abstract see *Ceram. Abs.*, **12** [2], 64–65 (1933). R.A.H.

Refractory linings for modern blast furnaces. MAURICE BARRETT. *Blast Fur. Steel Plant*, **21** [2], 123–24 (1933); for abstract see *Ceram. Abs.*, **12** [3], 112 (1933). E.J.V.

Refractory lining for rotary cement furnaces. D. S. *Corriere ceram.*, **13** [11], 411–13 (1932). M.V.K.

Report of Committee C-8 on refractories. ANON. *Proc. A.S.T.M.*, **32** [Part I], 352–56 (1932).—Committee C-8 recommended that the proposed tentative method of test for particle size of ground refractory materials be accepted as tentative and recommended as standard the tentative standard for testing the modulus of rupture of refractories. It also recommended the tentative revisions in the test for porosity and permanent volume changes in refractory materials to standard. These revisions substitute water for kerosene for determining porosity in the suspension method and provide for boiling the sample instead of a long immersion under vacuum at room temperature. Work of the subcommittees included (1) the completion of a standard sample of silica brick for which a provisional certificate has been issued by the National Bureau of Standards; (2) a survey of furnaces used to perform load test which included the compilation of reasons why variation exists in types of furnaces; (3) approval of measurement of warpage in refractories with the warpage meter developed at the Mellon Institute; and (4) extension of the present heating rate of 150°C an hour to include cones 36, 37, and 38 in P.C.E. determinations. R.A.H.

Historical review of the refractory industry. H. S. *Rev. mat. constr. trav. pub.*, No. 278, pp. 213–15*B* (1932).—S. discusses a report by J. D. Ramsay dealing with the amelioration of refractory brick and progress of the technique. M.V.K.

BOOKS

Dehydration of bauxite and bauxite minerals. (Die Entwässerung der Bauxite und Bauxitmineralien.) J. GYÖRKI. University of Dunantul, 1932. 29 pp. Re-

viewed in *Chim. & ind.*, **28** [6], 1356 (1932); for abstract see *Ceram. Abs.*, **12** [2], 64 (1933); see also *ibid.*, 12 [3], 124 (1933). M.V.K.

Magnesite and Its Use. R. Banco. *Blast Fur. Steel Plant*, **21** [2], 123 (1933); see also *Ceram. Abs.*, **11** [11], 577 (1932). E.J.V.

PATENTS

Method of making a molded article. A. M. Herbsman. U. S. 1,894,400, Jan. 17, 1933. A method of making a molded article consists in mixing an aggregate of refractory material with a water-soluble silicate and a material capable of uniting with the soluble silicate to form an insoluble silicate, molding the mixture to a given shape, heating the article thus molded to form the insoluble silicate, and fusing this to unite the particles of the aggregate.

Preservation of metallurgical furnace bottoms. A. T. Cape and K. B. Bowman (Republic Steel Corp.). U. S. 1,894,755, Jan. 17, 1933. The method of preserving metallurgical furnace bottoms, which are normally subject to disintegration by the expansion of slag which seeps therein and expands on solidification and subsequent cooling, consists in incorporating a borate with the slag before the latter solidifies.

Heat recuperating apparatus for the cowper type and a brick for the honeycomb structure. Georges Simon (Société anon. d'Ougree Marihaye). U. S. 1,895,235, Jan. 24, 1933.

Fire brick for checkerwork regenerators. B. P. Wheeler and W. G. Smith. U. S. 1,895,302, Jan. 24, 1933.

Treatment of bauxite, alunite, and like aluminous material. M. J. Martin and H. P. Brooksbank (Sulfates Proprietary, Ltd.). U. S. 1,895,580, Jan. 31, 1933. In the production of alkaline earth metal aluminates, the process consists of intimately mixing a substance of the bauxite alunite type with a suitable proportion of an alkaline sulfate with free sulfuric acid, forming the mixture into briquets, subjecting the briquets to the action of hot reducing gases, then subjecting the briquets to an oxidizing atmosphere, and lixiviating the crude alkaline aluminate, the materials used being crushed to such a size as to pass through a half-inch mesh before being pulverized to a suitable degree of fineness.

Furnace construction. G. W. Davey. U. S. 1,897,041, Feb. 14, 1933.

Method and material employed in the manufacture of refractory articles. H. E. White (Lava Crucible Co.). U. S. 1,897,183, Feb. 14, 1933. A material for making a refractory article comprises crystalline alumina in grain form and of high crystallization, crystalline mullite in grain form and having finer grains than the crystalline alumina, and a high alumina bonding clay.

Boron carbide and method of making. R. R. Ridgway (Norton Co.). U. S. 1,897,214, Feb. 14, 1933. A composition of matter comprises boron carbide having a composition which corresponds substantially with the formula B_4C.

Checker brickwork construction for regenerator furnaces. W. B. Mitchell. U. S. 1,897,270, Feb. 14, 1933.

Furnace walls. Babcock & Wilcox, Ltd. Brit. 386,916, Feb. 1, 1933.

Silica blocks. Hermann Salmang and Benno Wentz. Ger. 556,861, July 22, 1931. The method of 555,767 (*Ceram. Abs.*, **12** [3], 114 (1933)) for forming silica blocks is modified by firing the molded mixture at temperatures between 1050 and 1250°. (*C.A.*)

Refractory compositions. Arthur Sprenger. Ger. 557,153, Aug. 26, 1930. Refractory masses are obtained by fusing suitable materials together so as to produce a product containing at least 80% of a composition of the formula $z[x\text{FeO}\cdot\text{Al}_2\text{O}_3 + (2 - x)\text{FeO}\cdot\text{Cr}_2\text{O}_3] + 4[y\text{MgO}\cdot\text{Al}_2\text{O}_3 + (2 - y)\text{MgO}\cdot\text{Cr}_2\text{O}_3]$, in which z is between 0 and 1, and x and y are between 0 and 2. The remaining 20% or less of the product may comprise up to 15% of SiO_2. Numerous details are given. (*C.A.*)

Terra Cotta

Terra cotta slip coatings. Samuel J. McDowell. *Jour. Amer. Ceram. Soc.*, **16** [3], 134–40 (1933).

Conversion of periodic kilns from coal firing to natural gas for firing glazed clay products. Robert F. Grady, Jr. *Jour. Amer. Ceram. Soc.*, **16** [3], 141–51 (1933).

Manufacture of pottery for horticulture. Fried. Bigot. *Rev. mat. constr. trav. pub.*, No. 279, pp. 221–25*B* (1932).—Mechanical molding and hand molding processes of manufacturing flowerpots are discussed. The following points are of importance:

(1) sodium carbonate permits the production of porous bodies but its content must not exceed 10 or 12%; (2) sodium sulfate in large quantities is injurious; (3) an excess of iron oxide promotes vitrification of the body, lowering the porosity; (4) reduced firing also promotes vitrification; (5) the best bodies are those made of sandy clays with some iron oxide; and (6) the use of siliceous or quartz sand having round grains should be avoided. Different apparatus used for molding and drying are described. Firing may be done in any kind of furnace. A rectangular furnace specially adapted for firing flowerpots is described. M.V.K.

Anti-acid brick. G. MILANI. *Corriere ceram.*, **13** [11], 399–405 (1932).—The resistance of brick to acid depends mainly on (1) the insolubility in hydrochloric sulfuric, nitric, and acetic acids, (2) the amount of surface exposed to the corrosive action (porosity), (3) uniformity in the composition so that if the surface is corroded the inside will be equally resistant, and (4) use of an adequate cement. The raw materials, preparation, firing, and characteristics of anti-acid brick and the compositions of cements and coatings are given. M.V.K.

Making high-fired terra cotta from Iowa clays. H. S. LEWIS. *Ceram. Age*, **20** [6], 215–44 (1932).—L. reports the results of tests on terra cotta bodies made from a Fort Dodge clay. Three bodies were made up, each containing 60% clay and 40% fireclay grog. They differed in grog sizes, the maximum sizes in the three bodies being 14-, 28-, and 8-mesh, respectively. The bodies were fired to cone 7. The body containing grog from 14-mesh to dust proved to have the best properties. It had a porosity of 9.7%, a total shrinkage of 5.1%, and a modulus of rupture of 2505 lb./sq. in. The body showed no tendency to warp. Tests pieces fired to cone 13 showed no warping and had a porosity of about 3%. R.G.M.

Developing a high-fired terra cotta. W. F. STEARNS. *Ceram. Age*, **20** [5], 177–204 (1932).—S. describes an investigation of terra cotta bodies and glazes. It was attempted to duplicate the French product, "gres," using American materials as cheaply as possible. The best body developed, fired to cone 13, had the following composition: flint clay 30%, ball clay 10%, Scranton (Iowa) clay 60%. The clays comprised 60% of the batch, the remaining 40% being grog. This body had a modulus of rupture of 801 lb./sq. in., indicated no warpage, and had a good buff color. The glaze developed for the body was

$$\left.\begin{matrix}0.18\ K_2O\\0.62\ CaO\end{matrix}\right\}\ 0.46\ Al_2O_3\ 3.6\ SiO_2$$
$$0.12\ BaO$$
$$0.08\ ZnO$$

R.G.M.

Standard delivery specifications and standard methods for testing glazed earthenware tile. O. KALLAUNER. *Stavivo*, p. 81 (1931).—Preparatory work on standards and specifications, prepared by a subcommittee of the Czechoslovakian Ceramic Society, has been submitted in a final report to the Czechoslovakian Standards Assn. The standards include definitions, sorts, marking, packing and delivery, and properties such as appearance, dimensions, sound, texture, absorption, compressive strength, and resistance of the glaze to temperature changes. (*Trans. Ceram. Soc.* [Eng.])

Manufacture of majolica wall tile in Italy. K. THON. *Stavivo*, p. 133 (1931).—The methods applied at one of the oldest and largest works, near Bologna, are described. Volcanic earths and the products of their decay, marine sediments, and frequently marls are the raw materials. From 10 to 20% of tile grog is added to the body mixture. The green tile are dried over the kilns and are fired without saggers in round kilns. The glaze is applied mechanically. Glost firing is done in typical Italian muffle kilns at cones 08 to 05. (*Trans. Ceram. Soc.* [Eng.])

Roofing the American home. L. PRICE. *Amer. Home*, **9** [3], 117–28 (1933).—The use of both flat and half-round terra cotta tile in modern roofing is described and illustrated. F.G.H.

White Wares

Refining Pacific Northwest kaolins by air flotation. HEWITT WILSON AND JACK A. CUNLIFFE. *Jour. Amer. Ceram. Soc.*, **16** [3], 154–62 (1933).

Clay flow. A photographic study of some common flow phenomena in hot-pressing electrical porcelain. E. H. FISCHER. *Ceram. Age*, **20** [4], 136–39 (1932).—This article contains a number of photographs which show clearly the flow of clays in pressing operations. A white clay tracer was used to show the lines of flow. R.G.M.

Pyrophillite. R. V. TAILBY. *Ceram. Age*, **21** [1], 4–5 (1933).—T. discusses results of an investigation of fifteen bodies in a clay-pyrophillite-feldspar field. Pyrophillite was found advantageous as a nonplastic ingredient, not as a clay substitute, but as a new component. R.G.M.

Use of cyanite in the ceramic industry. G. L. EFREMOV. *Keram. i Steklo*, **8** [10], 13–15 (1932).—The numerous occurrences of cyanite in U.S.S.R., particularly in the Urals and Karelia, are discussed. Replacing quartz by fired cyanite in porcelain has been successful. The quality of the porcelain is improved and its mechanical and thermal resistance are increased. A table showing the influence of fired cyanite on the properties of porcelain is given. The utilization of cyanite for the production of super-refractory products and the investigations of Freed (*Ceram. Abs.*, **5** [7], 217 (1926)) are discussed. M.V.K.

Trend in tile testing described at Rutgers. ANON. *Ceram. Age*, **21** [1], 5 (1933).—The tests used in an investigation of wall tile at Rutgers Univ. are described. R.G.M.

Breaking dishes to save dishes. W. R. KNAPP. *Ceram. Age*, **20** [4], 132–63 (1932).—K. reports the results of tests of hotel china by the New York Testing Laboratories. The following properties were tested: (1) weights, (2) sizes, (3) chipping, (4) impact, (5) quenching, (6) hardness, and (7) absorption. Results of the tests are included in tabulated form. R.G.M.

Reversible expansion of clayware. XVIII. Thermal expansion of nonclayey raw materials. TOSAKU YOSHIOKA. *Jour. Jap. Ceram. Assn.*, **39** [458], 88–92 (1931).—One part of powdered quartz glass, silica gel, silicon carbide, sillimanite, obsidian, emery, alumina, garnet, corundum, steatite, glass, talc, or magnesia is mixed with 2 parts of Korean kaolin. The test pieces made of the mixtures are fired at 1000 or 1300°C for 1 hr. and their expansions are measured. The obsidian and glass test pieces fired at 1000° showed distinct tridymite effect at about 200°C. **XIX. Thermal expansion of intermediate layers existing between body and glaze.** *Ibid.*, **39** [459], 153–58 (1931).—Experiments have been made of the thermal expansion of mixtures of porcelain bodies and glazes. Conclusions are as follows: (1) It is probable that there are intermediate layers between the body and glaze of porcelain. (2) If dissolution of quartz is incomplete in a body, there is an intermediate layer whose expansion is lowest. (3) If the body and the glaze are fused almost perfectly, the expansion of any intermediate layer has a value between the body and the glaze. **XX.** *Ibid.*, **39** [461], 289–93 (1931).—Results obtained from studies of hydro-expansion and the method of forming test pieces for thermal expansion are discussed. Kaolins fired at 800 to 1000°C are heated in an autoclave at 9 to 12.2 atmospheric pressure, and their rate of loss of weight on heating is determined. The dehydration occurs gradually up to 700°C, showing no rapid losses at 400 to 500° as are usual of the raw kaolins. This fact indicates that the hydro-expansion is due to swelling of the gel. To find the effect of water content of plastic body on the expansion of its bisque, test pieces were formed from a commercial porcelain body by Y.'s extrusion press, using 3 different amounts of water which either made a good body or one that was hardly workable. The effect is slight, as shown in the following table:

	Water content (%)	Total expansion at 710°C (%)		
		1000°, 1 hr.	1100°, 1 hr.	1350°, 1 hr.
(1) With maximum water	23.5	0.462	0.505	0.374
(3) Most workable	21.0	0.448	0.504	0.377
(2) With minimum water	18.8	0.444	0.488	0.375
Difference between (1) and (2)	4.7	0.018	0.017	0.002

XXI. Study of low-expansion bodies. *Ibid.*, **39** [463], 429–32 (1931).—Extra low-expansion bodies showing a coefficient of expansion less than 0.000003 have been obtained. A body composed of Kaijo talc 43%, Korean kaolin 35%, and $Al(OH)_3$ 22% is an example. It is fired at 1350°C for 1 hr. The effects of the proportions of the talc, kaolin, and alumina on the expansion have been examined. For Parts XII–XVII see *Ceram. Abs.*, **11** [7], 422 (1932). S.K.

Discoloration of overglaze pigments due to excelsior. KAZUHIKO OMA. *Jour. Jap. Ceram. Assn.*, **39** [465], 573–75 (1931).—Excelsior is soft shavings of Hokkaido larch and is used for stuffing pottery. Overglaze colors are often stained black after 3 to 4 months. Green and reddish orange are especially sensitive. The latter consists of basic chromate of lead and is fired on at 700 to 850°C. Formerly, the discoloration

was ascribed to PbS which may be produced by the action of S compounds in fuel and organic acids in excelsior. No sulfide, however, was detectable on the surfaces of fresh ware. It was discolored into yellow of lead chromate by the action of organic acids. O. proposes an oxidation theory. Terpenes contained in the excelsior are oxidized by air to resinous matter, producing O_3 or H_2O_2. The latter oxidize the lead compounds to PbO_2. Fresh ware is blackened by the action of H_2O_2. On the other hand, the discoloration disappeared, due to the action of SO_2. The discoloration can be prevented by using wood containing no terpene or by introducing a reducing agent such as SO_2, urotropine, or $NaHSO_3$ to the excelsior. S.K.

Pottery manufacture. JIROKICHI KUMAZAWA. *Jour. Jap. Ceram. Assn.*, **39** [460], 247–50 (1931).—A. Research Laboratory of Aichi prefecture. (1) Low-tension stoneware insulator. Test pieces made of a Mikawa stoneware clay, feldspar, and quartz and fired to cone 4*a* showed puncture voltages ranging from 41 to 61 kv. per 5 mm. thickness. No relation was found between the voltage and their apparent vitrification. (2) Methods of shading underglaze color. Two methods were successful. In the first, pottery is painted with zaffre color, then it is fired or biscuited in a sagger in which bleaching powder or common salt is placed in a separate vessel; the oxide of cobalt is acted upon by Cl_2 and the boundaries are shaded. In another, bleaching powder or the salt is used at glost firing; Cl_2 produces volatile $CoCl_2$ and the painting is shaded. B. Pottery Laboratory of Gifu prefecture. (1) Leadless overglaze colors. The fluxes were prepared from $BaCO_3$ 10 to 20%, borax 40 to 50%, boric acid 10 to 20%, and quartz 20 to 30%. They cost only $^1/_{20}$, or less, of the price of bismuth fluxes. The colors are not acid resisting enough. (2) Overglaze lead colors. Fluxes composed of borax, boric acid, and potassium carbonate 70 to 0%, red lead 30 to 95%, and quartz 35 to 0% have been tested. See also *Ceram. Abs.*, **11** [7], 420 (1932). S.K.

Porcelain and its uses in electrical work. LÉON FRANCQ. *Rev. belge ind. verrières, céram., émail.*, **3** [6], 126–29 (1932).—A brief definition and history of the development of porcelain in general and a brief description of the method of manufacture are presented. Types of composition are shown. The general properties of the fired porcelains are tabulated and a comparison of the properties of porcelains and metals is made. It is shown that one desirable property may be had but at the expense of others in a single body composition. The glaze contributes materially to the physical properties. This is shown by tabulation. Different competing types of insulations are explained and discussed. Porcelain insulators used for several purposes are illustrated and diagrams show their behavior under test. These tests are approved by a collaboration between Deutsche Keramische Gesellshaft and Verein Deutscher Electrotechniker. The customary discharge types resulted from these tests. F. summarizes the desirable qualities in porcelain insulators, *e.g.*, high dielectric strength, constant dielectric at high potentials, and low loss factor. P.E.C.

Compressive strength of porcelain. SEIJI KONDO AND NOBORU HIRODO. *Jour. Jap. Ceram. Assn.*, **40** [472], 254–56 (1932).—The compressive strengths of porcelains composed of a Gairome kaolin, an Amakusa liparite, and a feldspar fired to cone 6*a* to 12 were examined. The strengths range from 3640 to 4720 kg./sq. cm. They are closely related to their porosities. Those test pieces which had been fired at temperatures slightly higher than those making their porosities zero have shown highest strengths. S.K.

Change in microstructure of porcelain bodies occurring in their softening. SEIJI KONDO AND TEIROKU SUENO. *Jour. Jap. Ceram. Assn.*, **39** [458], 93–102 (1931).—Results obtained by the microscopic observation of 51 porcelain bodies fired to cone 13 to 14 or tested for the softening behavior under a load of $^1/_2$ kg./sq. cm. after firing are discussed. The results can be summarized as follows: (1) Porcelain bodies consist mainly of glass, quartz, yellow spots, mullite, and minute grain with low index of refraction. (2) The softening reduces the amounts of quartz and the minute grain with low index of refraction, aids the development of glass, mullite, the yellow spots, and minute crystals in the spots, and makes the glass uniform. (3) It is probable that the softening behavior is influenced most by the nature of the glass. The index of refraction of the glass seems to rise with an increase of quartz in a body. S.K.

Porcelain dissolving cone. ANON. *Laboratory*, **5** [1], 10–11 (1932).—A perforated porcelain cone glazed inside and outside facilitates the solution of solids. Illustrated. F.G.H.

Soviet porcelain. R. BARTA. *Stavivo*, p. 241 (1931).—Five distinct trends in the type of decoration of modern Soviet porcelain are noted and described briefly. At the State Porcelain Works at Leningrad about 15% of the output is artistic ware, the remainder being for technical purposes. The following bodies are produced: ordinary

semiporcelain, a so-called "English" porcelain for artistic purposes, ordinary technical porcelain, chemical ware, a body for thick-walled ware, electrical insulator body, porous porcelain body, two bodies for tubes and pipes and Marquard bodies, and soft porcelain for figures. Seger cones are also manufactured. (*Trans. Ceram. Soc.* [Eng.])

Spark plugs for motors. S. G. PULIESO. *Keram. i Steklo*, **8** [10], 15–16 (1932).—The requirements for porcelain used in the manufacture of spark plugs are described. M.V.K.

Ceramic insulations. III. H. WARREN. *Electrician*, **108**, 98 (1932).—A general discussion is presented of the three types of ceramic insulating materials, stoneware, porcelain, and steatite. (*Trans. Ceram. Soc.* [Eng.])

Manufacture of Staffordshire teapots. A. NORMAN ESPLEY. *Pottery Gaz.*, **58** [668], 229 (1933).—In explaining how and why the manufacture of teapots became a recognized industry in North Staffordshire, E. took up the geology of the clays of the district, the history of the beginnings of the potteries, the treatment of teapot clay, and the natural advantages of the district. E.J.V.

Meissen porcelain. R. BARTA. *Stavivo*, p. 337 (1931).—A general historical sketch is followed by a brief account of the manufacturing methods and the different types of ware produced. Trade marks of Meissen ware are reproduced. (*Trans. Ceram. Soc.* [Eng.])

Development and technology of the Czechoslovakian pottery industry. H. LANDSFELD. *Zprávy Československ. keram. společnosti*, **8**, 178 (1931).—Czechoslovakian pottery is not easily distinguished from Haban ware. The development of the industry commenced in 1686, when the Anabaptists abandoned property communism. In the third quarter of the 19th Century porcelain manufacture began to supersede the ordinary pottery industry, and at present only three works exist. See also abstract by Cernohorsky, *Ceram. Abs.*, **12** [3], 92 (1933). (*Trans. Ceram. Soc.* [Eng.])

PATENTS

Strain insulator. WALTER CRAMER (Locke Insulator Corp.). U. S. 1,894,292, Jan. 17, 1933.

Connection for high-voltage lines. A. O. AUSTIN (Ohio Brass Co.). U. S. 1,894,338, Jan. 17, 1933.

Electric switch. A. O. AUSTIN (Ohio Brass Co.). U. S. 1,894,339, Jan. 17, 1933.

Insulator pin. A. O. AUSTIN (Ohio Brass Co.). U. S. 1,894,340, Jan. 17, 1933.

Toilet bowl. J. H. BENNETT. U. S. 1,894,846, Jan. 17, 1933.

Electrical apparatus and insulating bushing therefor. G. E. JANSSON (Condit Electrical Mfg. Corp.). U. S. 1,894,993, Jan. 24, 1933.

Tank and bowl connection. F. G. BROTZ. U. S. 1,895,145, Jan. 24, 1933.

Apparatus for protecting power-line insulators. H. P. SLEEMAN (R. Thomas & Sons Co.). U. S. 1,896,189, Feb. 7, 1933.

Prong-type holder for safety testing device. C. H. SPANGLER (Metropolitan Edison Co.). U. S. 1,896,598, Feb. 7, 1933.

Insulator. P. G. BRINEY. U. S. 1,896,937, Feb. 7, 1933.

Vacuum-type insulating bushing. G. E. JANSSON (Condit Electrical Mfg. Corp.). U. S. 1,897,257, Feb. 14, 1933.

Equipment and Apparatus

Eliminating dust nuisance by air-handling methods. JOHN WEITS. *Ceram. Age*, **20** [4], 152 (1932).—Pneumatic conveyers may be used effectively for the elimination of dust in transferring bulk materials. The vacuum system consists of three major parts: (1) a vacuum pump for producing the required air currents, (2) a recipient or expansion tank where the material can be separated from the air and discharged, and (3) a conveying pipe with flexible hose and intake nozzle. A system installed at the Schenectady, N. Y., plant of the General Electric Co. is described. It is used for moving flint and feldspar from box cars into storage or service tanks. Each unit has a capacity of five tons of material per hour and requires one man. The advantages of the system are low-cost production and sanitary working conditions. R.G.M.

Framed-bag dust collectors. BLAW-KNOX CO. *Power*, **76** [2], 102 (1932).—Low weight per unit of capacity, a special cleaning mechanism, easy cloth hanging, compactness, and low erection cost are features of these all-metal dust collectors using cloth filters. F.G.H.

Selection and installation of ventilating fans. C. L. HUBBARD. *South. Power Jour.*, **50** [2], 46–49 (1932); abstracted in *Mech. Eng.*, **54** [5], 381 (1932).—Facts are given concerning the use of data, tables, and tests furnished by manufacturers of fans to aid the engineer in choosing and installing such equipment. Type of fan, speed, horsepower requirements, drives, heads, and duct requirements are included. F.G.H.

Magnetic separation extended to new materials. ANON. *Ceram. Age*, **21** [1], 12 (1933).—A magnetic separator for materials which are feebly magnetic is described. The material is poured down a 45° slope over a laminated rotor of the induction type. Adjustment of the magnetic field of the rotor is very fine so that the more magnetic material tends to stay on the rotor for a little longer period than the less magnetic substance. Thus the two materials are separated into two streams which issue from the machine at slightly different angles, being separated by means of a baffle plate. Glass sand in which the Fe_2O_3 content has been reduced to 0.005% has been obtained. Waste clays containing 17% of iron have been tested in large quantity with the result that a 50% recovery of clay containing less than 2.5% of iron has been effected. It is generally impossible to effect economical separation of materials less than 100-mesh in size. The substance must be dry enough to flow freely. R.G.M.

Machine counts sand grains. J. E. APPEL. *Popular Sci. Monthly*, **121** [4], 96 (1932).—A., Univ. of Chicago geologist, has developed a device for the analysis of sediments. Fitting on the end of a suction hose, it is equipped with a thin brass plate containing 300 minute holes. Since the holes are smaller in diameter than the grains being counted, a single grain is attracted to each hole and is held there by suction. When every hole is holding a grain, the sand is carried off to a separate pile and another 300 grains are picked up. As many as 10,000 sand grains an hour may be counted. F.G.H.

Ascertaining brick machine defects. ANON. *Brit. Clayworker*, **41** [489], 328 (1933).—An instructive experiment can be made by removing the die from a brick machine and placing a pancake of white clay paste on the surface of the clay in the barrel of the machine, replacing the die, and working the machine until a long column of clay has been extruded. By cutting the column vertically, lengthwise, and then horizontally, if the machine is working properly, the white clay will take the form of one-half of an elongated elipse, but if the machine works irregularly the white clay will assume all kinds of curious shapes. The use of such a tracer will show the cause of laminations, irregular working of the knives, or a displacement of the shaft. R.A.H.

Study of apparatus for cutting brick, etc. PIERRE RENAULT. *Rev. mat. constr. trav. pub.*, No. 279, pp. 234–37*B* (1932); see also *Ceram. Abs.*, **11** [11], 584 (1932). M.V.K.

Apportioning weigher for the continuous conveyance of uniform quantities. KARL DIEHL. *Eng. Progress*, **14** [1], 13–14 (1933).—The material to be measured passes from the storage bin through an adjustable feeding gate onto the feed belt and from there onto the weighing belt which conveys it to the mixing machine. The speed of the feed belt is automatically varied to keep constant the weight of material delivered from the weighing belt. J.L.G.

Use of the camera lucida in crystal drawing. W. M. MCNABB AND JOSEPHINE W. MCNABB. *Amer. Mineralogist*, **18** [1], 14–19 (1933).—A method for drawing typical crystals accurately is described. The method combines the use of the camera lucida and the gnomonic projection, a camera lucida drawing being used as the basis of the orthogonal plan. The method is especially applicable to artificial crystals, the size conveniently used being about 0.1 to 1 mm. in diameter. G.R.S.

Trichromatic colorimeter. R. A. HOUSTON. *Trans. Opt. Soc.*, **33** [5], 199–209 (1932).—The design and construction of the instrument are described. It is on a new principle, the intensity of the comparison field being altered by an iris diaphragm and the color by moving a magenta-yellow and a blue-magenta filter relatively to one another. Results are given which have been obtained with the instrument. J.T.L.

Standard of length. ANON. *Mech. World*, **92** [2393], 460 (1932).—A paper entitled "A New Apparatus for Determining the Relationship between Wave-Lengths of Light and the Fundamental Standards of Length," by J. E. Sears, Jr., and H. Barrell, of the Metrology Dept. of the National Physical Laboratory, has been published in the *Philosophical Transactions* of the Royal Society. The new apparatus, called the wave-length comparator, is described. The authors compare the length of a wave of red light with the lengths of the present fundamental standards of length known as the imperial standard yard and the international prototype meter. E.P.R.

Theory and tests of venturi pressure-drop augmentor. SOCIÉTÉ RATEAU. *Mech. World*, **93** [2403], 49–50 (1933).—A pressure-drop augmentor is composed of several

ejectors working in series, and is used to obtain accuracy in measurement or sensitiveness of regulation of the quantity of fluid flowing through a pipe. To obtain minimum pressure loss only a small fraction of the flow passes through the reduced orifice, the pressure of the total mass of fluid thereby being only slightly affected. The most simple method of measuring the flow of a gaseous fluid is that of inserting in the piping a calibrated orifice in which the increased velocity produces a pressure drop between its two faces. The velocity being related by a well-known law to pressure drop, the reading of this latter by a differential pressure gage enables the flow to be determined. The variation of the pressure drop with the flow is equally utilized as a regulating agent. To render the flow or output of a blast-furnace blower constant and independent of the delivery pressure, the orifice pressure drop must act upon the motor control gear. This can also be adapted to the control of the antisurging device. R. develops a method of calculation and gives formulas. E.P.R.

Temperature measurement: electrical and optical devices used in pyrometry. P. M. HOGG. *Electrician*, **107**, 736–38 (1931).—The types of pyrometry reviewed are resistance, thermoelectric, and radiation. Radiation pyrometry may be divided into (1) total radiation pyrometry, and (2) optical pyrometry. (*C.A.*)

Metal wear and what it costs. W. C. RUECKEL. *Ceram. Age*, **21** [1], 9 (1933). R.G.M.

Metal wear and the ceramist's problem. H. W. GILLETT. *Ceram. Age*, **21** [1], 6–8 (1933). R.G.M.

What metal wear means to the ceramic industry. C. E. BALES. *Ceram. Age*, **21** [1], 8–9 (1933). R.G.M.

Wear-resisting metal for dry pans. M. C. BOOZE. *Ceram. Age*, **21** [1], 25 (1933). R.G.M.

Piping a sand-water mix. C. L. MANTELL. *Heating, Piping, Air Conditioning*, **5** [2], 87 (1933).—After trying several types of pipe for carrying a fill mixture of sand and water into a mine, a standard steel pipe 3 in. in diameter in 12 ft. lengths and having a $^1/_4$-in. rubber lining was used with ordinary flanges. The rubber lining was brought out over the face of the flanges and acted as a gasket for the joint. Over a period of 16 months more than 200,000 tons of sand were put through the lines with negligible wear on the rubber lining. Other types of pipe had failed after a short time. A screen analysis of the sand used is given. Illustrated. J.L.G.

Chart and formulas for flow of oil in pipes. W. B. MORTON. *Power*, **76** [4], 194 (1932). F.G.H.

Manganese ore-handling plant on the Gold Coast. ANON. *Gen. Elec. Co. Jour.; Iron Coal Trades Rev.*, **125** [3365], 304–305 (1932).—A new ore-loading plant at Takoradi is described which is capable of handling 1000 tons of ore per hour direct from rail by means of a car dumper, and into ship or storage via a scheme of belt conveyers and a traveling bridge. All of the plant is electrically operated. 4 illustrations. W.E.R.

Dispersion mill in colloid chemistry. ANON. *Laboratory*, **5** [1], 6–8 (1932).—The design and operation of a typical dispersion mill are described and illustrated. F.G.H.

Electric timer for the laboratory. ANON. *Laboratory*, **5** [5], 76–77 (1932).—An electric clock is described which has a device for the automatic indication of time intervals from 1 to 120 minutes. At the expiration of the interval for which it has been set a buzzer produces a horn-like sound which can not be mistaken. Illustrated. F.G.H.

Iridium furnace for temperatures up to 2000°. ANON. *Umschau*, **37** [5], 91 (1933).—A cheap laboratory furnace made of an iridium and thorium alloy for temperatures from 2000 to 2050° is described. M.V.K.

Resistor material for electric furnaces for high temperatures. GUNNAR NORDSTRÖM. *Tek. Tid., Uppl. C, Bergsvetenskap*, **61**, 55–59, 68–70, 77–78 (1931).—The earlier use of amorphous C and graphite for resistor elements for electric furnaces is reviewed. Recent experiences with the most extensively used nonmetallic resistor elements, silit and globar, are discussed. A diagram of the mounting and cooling arrangement of globar elements and 3 photographs of globar furnaces are shown. The efficiencies of resistor elements of Pt, Rh, Ir, W, Ta, and a number of alloys, particularly nichrome, are described. Resistance of nichrome to H_2S, SO_2, and reducing gases is discussed. Recent investigations carried out at Bultfabriks a.-b. in Hallstahammar have resulted in the production of a new alloy, Kanthal, melting at 1650 to 1670° and containing a minimum of 60% Fe and the rest mainly Cr, Al, and Co. Its ferritic structure does not change on heat treatment. Its resistance to oxidation and to H_2S, SO_2, and reducing gases is exceptionally good. Its electric resistance is 15 to 20% higher than for the best nichrome alloys. Its temperature coefficient is slightly positive. Tested for durability

under the conditions proposed by Bash and Harsch (*C. A.* **23,** 83), Kanthal proved to be far superior to nichrome. (*C.A.*)

High-temperature experimental furnace. P. F. THOMPSON. *Jour. Soc. Chem. Ind.* [Victoria], **32,** 693–99 (1932).—A miniature blast furnace in which temperatures up to 1800° can be obtained is described. It comprises a shaft of magnesite or chromite brick 14 in. high and 4 in. square into which is placed a vertical Carbofrax tube to contain the charge. The space above the grate between the tube and the brick is filled with gas-C (1/4 – 1/2 in.) which is burned by blowing air from below the grate by means of a small Roots' blower. (*B.C.A.*)

Making uniform jets. ANON. *Gas Jour.*, **201** [3634], 93 (1933).—To insure uniform air-gas ratio for combustion, the gas jets were calibrated. A diagram of the calibrating machine is shown and its operation is described. Results of the tests are given in a table. G.R.S.

Evolution of the thermometer. ANON. *Laboratory*, **5** [2], 18–21 (1932).—A brief history of the thermometer from the time of Galileo to the present is given. Illustrated. F.G.H.

Doing big things in a small way. ANON. *Laboratory*, **5** [5], 78–79 (1932).—A few of the microchemical tools used and the operations involved in microchemical investigations are briefly described. Illustrated. F.G.H.

BOOK AND BULLETIN

Handbook of Industrial Temperature and Humidity Measurements and Control. M. F. BEHAR. *Abrasive Ind.*, **14** [2], 23 (1933); see also *Ceram. Abs.*, **12** [3], 134 (1933). E.P.R.

Blowers and compressors. ROOTS-WILBRAHAM CO. *Bull.* 170–*B*10; *Foundry*, **60** [13], 67 (1932).—Centrifugal blowers and compressors designed primarily for oil and gas furnaces are described. Inherent characteristics are presented and information is included on construction. F.G.H.

PATENTS

Method of molding ceramic materials. H. L. CROWLEY (Henry Crowley & Co., Inc.). U. S. 1,894,368, Jan. 17, 1933.

Viscometer. GEORG DUFFING. U. S. 1,894,369, Jan. 17, 1933.

Elutriating means. M. A. LISSMAN (International Precipitation Co.). U. S. 1,894,623, Jan. 17, 1933.

Tunnel drier. T. W. GARVE. U. S. 1,897,387, Feb. 14, 1933.

Atomizer control. J. B. SCHMITT (De Vilbiss Co.). U. S. 1,897,679, Feb. 14, 1933.

Spray gun nozzle. R. W. TRACY (De Vilbiss Co.). U. S. 1,897,683, Feb. 14, 1933.

Apparatus for drying pottery, tile, etc. W. H. GRINDLEY, D. G. NORMAN, G. GREATBATCH, AND A. MASSEY. Brit. 385,402, Jan. 4, 1933.

Filter cloths. SOC. DES ÉTABLISSEMENTS DAUBRON. Fr. 729,531, March 21, 1931. Form of cloth is given. (*C.A.*)

Means for grading clay or kaolin by fractional settling from suspension. GUSTAV SCHOENBERG. Ger. 557,356, April 5, 1930. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Muffle kiln of high efficiency. F. H. NORTON AND J. V. DUPLIN, JR. *Jour. Amer. Ceram. Soc.*, **16** [3], 152–53 (1933).

Firing annular kilns. R. SVEJDA. *Stavivo*, p. 266 (1931).—Certain apparently contradictory phenomena are pointed out. Under certain circumstances the fire progresses well with little draft and is slower with a strong draft. This is due to resistance in the flues. The cause of apparently increased draft is, in most cases, slag accumulation in the ash pit. (*Trans. Ceram. Soc.* [Eng.])

Pottery firing by tunnel kilns and gas. S. R. HIND. *Pottery Gaz.*, **58** [668], 191–95 (1933).—With 5 basically different types of ovens and 5 or more available fuels, there are at least 25 definitely different designs of kilns possible. A comparison of costs of different fuels according to their cost per unit heat basis is made. The elimination of smoke by the use of producer gas and fuel oil, and results with gas kilns and gas-fired tunnel kilns are discussed in detail. Further modernization and greater use of gas-fired tunnel kilns are prophesied. E.J.V.

Some factors affecting the operation of ceramic furnaces. R. J. SARJANT. *Ind. chimique*, **19** [227], 917 (1932).—S. discusses the utilization of metals resistant to high

temperatures in the construction of ceramic furnaces. These metals may be classified into the following groups: (1) Chromium steel with a little nickel and molybdenum is employed where superheated steam is utilized and where the temperature rises to 600°. (2) Steel containing from 18 to 25% chrome, 7 to 12% nickel, and sometimes some silica and tungsten is used for temperatures up to 950°. (3) Iron and chrome alloys containing 0.5 to 2% carbon and 2.5 to 3% chrome and steels containing 15 to 30% chrome and 12 to 80% nickel are used at temperatures up to 1100°. Such steel is highly resistant to oxidation. M.V.K.

Gas circulation in the continuous furnace. A. BRANDL. *Arch. Eisenhüttenwesen*, **5** [12], 609–13 (1932). (*B.B.N.F.M.R.A.*)

Practical clayworking. ANON. *Brit. Clayworker*, **41** [489], 329–30 (1933).—The properties desirable in coals and coke for firing kilns, *e.g.*, length of flame, sulfur content, behavior when burning, character of ash, etc., are discussed. R.A.H.

Coal classification. D. J. W. KREULEN. *Chem. Weekblad*, **29**, 367–71 (1932); abstracted in *Power*, **76** [3], 159 (1932).—A new method based on chemical oxidation is proposed as being more precise than the long accepted method of classifying coals according to their content of volatile matter. It is shown that there is a relation between the tendency to form humic acids and the ratio of fixed carbon to volatile matter. F.G.H.

How anthracite coal burns. R. S. JULSRUD. *Power*, **76** [5], 253–54 (1932).—Combustion principles involved in the efficient combustion of anthracite coal are discussed. The combustion process is traced through the three stages of distillation, oxidation, and reduction, and the need of providing sufficient overfire air is pointed out. Illustrated with graphs and diagrams. F.G.H.

Coal buying and selling. A. A. BEMENT. *Power*, **76** [2], 88–89 (1932).—The difficulties involved in the buying and selling of coal on a guaranteed-quality basis are discussed. F.G.H.

Heavy oil firing of intermittent pottery kilns. MIKIYA AKATSUKA. *Jour. Jap. Ceram. Assn.*, **39** [458], 67–87 (1931).—Descriptions and discussions are given on heavy oils, oil-burning equipment, kilns, construction of combustion chambers, method of firing porcelain ware, tile and terra cotta, comparison with coal firing, and erection cost. S.K.

Less heat for circulated oil. W. J. TANGERMAN. *Power*, **76** [5], 228–29 (1932).—Economies are described in the maintenance of heavy-gravity fuel oil flow in circulating systems during winter months. F.G.H.

Fuel oil situation in New England. D. D. EAMES. *Power*, **76** [1], 12–14 (1932).—Though directed specifically to New England, the basic information is of practical value to users of fuel oil everywhere. F.G.H.

Butane, new industrial gas, shipped as liquid. G. R. BENZ. *Steel*, **88**, 42–46 (May 7, 1931).—The properties of commercial butane are compared with those of other common industrial gases. This fuel is used for many industrial heating processes, including heat treatment and metal-melting furnaces. (*J.I.S.I.*)

Gas in industry. E. S. DAVIES. *Gas Jour.*, **201** [3634], 98–100 (1933).—Gas is compared with oil, coal, and electricity in industrial heating problems. G.R.S.

Combustion of solid, liquid, and gaseous industrial fuels. H. L. PIRIE. *Gas Jour.*, **201** [3634], 96–98 (1933).—Calculations of typical examples of combustion of (1) blast-furnace gas, (2) producer gas, (3) coke-oven gas, and (4) liquid fuels are given. G.R.S.

Measurements of solids in smoke. E. C. HUTCHINSON. *Power*, **76** [1], 24 (1932).—Recent investigations of various research organizations upon this subject are described. It is suggested that an accurate means of gas sampling might be evolved if more consideration were given to a study of the laws of streamline and turbulent flow and the influence of the shape of ducts upon the efficiency of flow. F.G.H.

Combustion of fuels. Y. OSHIMA AND Y. FUKUDA. *Jour. Faculty Eng.*, **20**, 65–99 (1932); *Power*, **76** [3], 159 (1932); see also *Ceram. Abs.*, **12** [2], 74 (1933). F.G.H.

Diffusion flame combustion. H. C. WELLER. *Heat Treating & Forging*, **18** [12], 701–703 (1932).—Results are given for the use of burners on a boiler plate heating furnace, hammer forge furnace, slot forges, annealing furnaces, a normalizing furnace for stampings, a furnace for heating copper ingots, and on a hot mill billet heating furnace. A general discussion of diffusion flame combustion and its future possibilities is given. See also *Ceram. Abs.*, **12** [2], 74 (1933). J.L.G.

Specific heat of air and gaseous products of combustion. P. B. PLACE. *Heat Treating & Forging*, **18** [6], 376–78 (1932); for abstract see *Ceram. Abs.*, **11** [2], 128 (1932). J.L.G.

Thermal and electrical theories of ignition. J. D. MORGAN. *Fuel Sci. Prac.*, **11** [12], 452–56 (1932). R.G.M.

BULLETINS

Oil burners. ENTERPRISE OIL BURNER CO. *Foundry*, **60** [13], 66 (1932).—Three types of oil burners are described in this bulletin, one for cheap fuel oil, the second for lighter oil, and a third for heavy oil. Illustrated. F.G.H.

Burning of Liquid and Gaseous Fuels. ANON. Nat. Elec. Light Assn. Pub., No. 219; abstracted in *Power*, **76** [1], 56 (1932).—This publication includes data on liquid and gaseous fuel market conditions, automatic combustion control, air heaters, use of oil and gas as auxiliary fuel, corrections in gas meters and gas calorimeters, rates of furnace heat liberation, and similar subjects. F.G.H.

Deviation of natural gas from Boyle's law. T. W. JOHNSON AND W. B. BERWALD. Bur. Mines *Tech. Paper*, No. 539. 29 pp. Supt. of Documents, Govt. Printing Office, Washington, D. C. 5¢. Previous authoritative reference in literature to the deviation of natural gas from Boyle's law was confined largely to *Tech. Papers*, Nos. 131 and 158, but the data presented were for relatively low pressures. In the present work the pressures are of ranges found in high-pressure natural gas transmission lines and in underground reservoirs. R.A.H.

PATENTS

Electric furnace. G. L. SIMPSON (Pittsburgh Research Corp.). U. S. 1,895,269, Jan. 24, 1933.

New Habla staggered kiln. R. HABLA. Czechoslo. 30,556; *Stavivo*, p. 108 (1931).—The partitions are not walls of solid construction but are made of unfired brick; thus kiln efficiency is increased and floor space is considerably reduced. Prime costs are lower, because in comparison with a round Hoffman kiln (100%) an ordinary staggered kiln has an area of 78%, whereas the Habla kiln has only 27%. There is also a great saving in fuel. See also abstract by Helan, *Ceram. Abs.*, **12** [3], 121 (1933).
(*Trans. Ceram. Soc.* [Eng.])

Geology

Classification of igneous rock series. M. A. PEACOCK. *Sci. Progress*, **27**, 211 (1932); for abstract see *Ceram. Abs.*, **10** [10], 727 (1931). H.H.S.

Cinnabar and associated minerals from Pike County, Arkansas. R. G. SOHLBERG. *Amer. Mineralogist*, **18** [1], 1–8 (1933). G.R.S.

Barium and its industry. E. LEMAIRE. *Ind. chimique*, **19** [226], 819 (1932).—L. discusses different methods used for the production of barium salts from the minerals barite and witherite. M.V.K.

Crystallization of pyroxenes. S. TSUBOI. *Jap. Jour. Geol. Geog.*, **10**, 67–82 (1932); *Nature*, **130** [3296], 1004 (1932). J.L.G.

Importance of the chemistry of titanium and its compounds to national economy. I. F. BAIKOV, A. O. SAVICH, E. N. BOGOYAVLENSKII, AND A. M. BRUSILOVSKII. *Lako-krasochnuyu Ind.*, No. 1–2, pp. 22–28 (1932).—The possibilities of the Ti industry and ways for its development are pointed out. (*C.A.*)

Formation of kaolin and alunite in the eastern part of the Holy Cross Mountains, near Sandomierz. J. KUHL. *Bull. intern. acad. polonaise*, **A**, 665–75 (1931).—Microscopical and chemical investigations of a white substance in veins between slate and quartzite show that it belongs to the kaolin class, with $Al_2O_3 : SiO_2 : H_2O = 1 : 2.15 : 1.80$. It has been formed by action of small amounts of H_2SO_4, formed from pyrite, on the aluminosilicates contained in the slate. The veins contain also epsomite, mirabilite, and alunogen (keramohalite). (*C.A.*)

BOOKS AND BULLETINS

Transactions of the American Institute of Mining and Metallurgical Engineers. Volume 102, Metal Mining, Nonferrous Metallurgy, Nonmetallic Minerals, Mining Geology, 1932. 352 pp. In the section on nonmetallic minerals, "Magnetic beneficiation of nonmetallics," by Samuel G. Frantz and G. W. Jarman, Jr., describes the use of magnetic forces of previously unattained magnitude applied in an improved manner, giving results in the commercial separation of muscovite from feldspar, concentration of cyanite, etc. "Mining and treatment of the sillimanite group of minerals and their use in ceramic products," by F. H. Riddle (*Ceram. Abs.*, **11** [4], 252 (1932)), and "Geology

of some kaolins of western Europe," by E. R. Lilley (*ibid.*, **11** [5], 322 (1932)), are included. W.E.R.

German-English Geological Terminology: An introduction to German and English terms used in geology, including mineralogy, petrology, mineral deposits, etc. ARNOLD CISSARZ AND WILLIAM R. JONES. xvii + 250 pp. Thomas Murby and Co., London, D. Van Nostrand Co., New York, 1931. 12s 6d net. *Nature*, **130** [3286], 619–20 (1932).—A brief review of the book is given. The reviewer finds the book intended for those who have already obtained some knowledge of German (or English) but are not familiar with German equivalents of special terms used in the various branches of geology. It is arranged on the plan of an elementary text and is bilingual. All scientific terms are italicized when first used and equivalent portions of the text are arranged on opposite pages. The reviewer believes that a mastery of the book's contents should equip one adequately for the reading of geological literature in the original German. J.L.G.

Key to Mineral Groups, Species, and Varieties. E. S. SIMPSON. viii + 84 pp. Chapman and Hall, Ltd., London, 1932. 10s 6d. *Nature*, **130** [3286], 620 (1932).—S. has listed about 1800 mineral names in alphabetical order. Opposite each mineral name are given its chemical composition, specific gravity, crystal system, and refractive indices. All data have been gathered from the latest and most accurate sources available. In every case, reference is given to a source of detailed information for each mineral. Since the literature of mineralogy is cumbered with a great number of nearly useless names, S. has omitted names which he regards as obsolescent or which stand only for minute differences in unessential characteristics. J.L.G.

Form and Properties of Crystals: An Introduction to the Study of Minerals and the Use of the Petrological Microscope. A. B. DALE. x + 186 pp. University Press, Cambridge, 1932. 6s. *Nature*, **131** [3298], 44 (1932). J.L.G.

Textbook of Geology. I. Physical Geology. CHESTER R. LONGWELL, ADOLPH KNOPF, AND RICHARD F. FLINT. *Bull. Amer. Assn. Petroleum Geol.*, **16** [11], 1160 (1932); see also *Ceram. Abs.*, **12** [2], 78 (1933). G.M.H.

Earth History. LUTHER C. SNIDER. The Century Co., New York, 1932. 675 pp. 300 illustrations. Reviewed in *Bull. Amer. Assn. Petroleum Geol.*, **16** [10], 1045 (1932). G.M.H.

Mineral Resources of the U. S., 1930. II. Nonmetals. 879 pp. $1.50. Published by the Bur. of Mines. Sold by the Supt. of Documents, Govt. Printing Office, Washington, D. C. R.A.H.

Chromite in 1931. L. A. SMITH. Bur. Mines *Mineral Resources U. S.* 14 pp. Price 5¢ from Supt. of Documents, Govt. Printing Office, Washington, D. C. R.A.H.

Chemistry and Physics

Volumetric determination of manganese after oxidation by periodate. H. H. WILLARD AND J. J. THOMPSON. *Ind. Eng. Chem.* [Anal. Ed.], **3** [4], 399–401 (1931).—Manganese up to 30 mg. can be determined by oxidation to permanganate with periodate in either phosphoric or sulfuric acid solution, removal of excess periodate by precipitation as mercuric salt, and reduction of the permanganate by standard ferrous sulfate. The reaction goes best in a phosphoric acid solution, in which case less than a milligram of chromium does not interfere. Cobalt, cerium, and chloride must be absent. R.G.M.

Fluxing of ashes and slags as related to the slagging type furnace. P. NICHOLLS AND W. T. REID. *Fuel Sci. Prac.*, **11** [10], 377–86 (1932); see also *Ceram. Abs.*, **12** [1], 31 (1933). R.G.M.

Quantitative determination of calcium by the magneto-optic method. E. R. BISHOP AND C. B. DOLLINS. *Jour. Amer. Chem. Soc.*, **54** [12], 4585–88 (1932). R.G.M.

Applications of ceric sulfate in volumetric analysis. X. Determination of antimony and arsenic. N. H. FURMAN. *Jour. Amer. Chem. Soc.*, **54** [11], 4235–38 (1932); for Part IX see *Ceram. Abs.*, **10** [12], 863 (1931). R.G.M.

Transmission of light in diffusing media. R. F. HANSTOCK. *Trans. Opt. Soc.*, **33** [4], 137–49 (1932).—The transmission of light by thin films of diffusing material is investigated, a flicker photometer being used for this purpose. The intensity, I, of the diffuse light transmitted by a thin film in the direction which is normal to the surface is related to the film thickness, x, by the empirical equation, $1/I = C(1 + ax + (ax)^2)$; where a is a constant depending on the opacity of the material of the film to diffuse light and C is approximately constant for all substances. The ability of a film to hide a

contrasting background is proportional to the quantity $H = 1/I$, complete hiding being attained for a value of H which is constant for all the materials investigated, *viz.*, a variety of white and colored paints and papers. An accurate method of measuring the hiding power of such films is described. J.T.L.

Space group of afwillite, $3CaO{\cdot}2SiO_2{\cdot}2H_2O$. C. GOTTFRIED. *Z. Krist.*, **84** [1–2], 172–73 (1933).—The crystals have monoclinic symmetry and prismatic habit. Density is 2.63. X-ray data and a discussion are given. G.R.S.

Technique for determination of densities and porosities. H. R. BRANKSTONE, W. B. GEALY, AND W. O. SMITH. *Bull. Amer. Assn. Petroleum Geol.*, **16** [9], 915–23 (1932).—Gealy's modification of Russell's method is one of the best rapid methods for routine determination of densities and porosities of rock samples. It is the same as developed by Purdy for determining the open and sealed pores in fired clay products. G.M.H.

Spectroscopic detection of small quantities of elements. W. SPATH. *Wiener Ber.*, 11*b*-141; *Nature*, **131** [3297], 30 (1933).—Droplets of solution were evaporated on copper electrodes and the spectra were excited by a condensed spark or by a break-contact arc depending on which type of lines were more persistent for a given case; 10^{-10} grams of cadmium and the same amount of manganese, 10^{-7} grams of arsenic, 10^{-7} grams of tellurium, 10^{-9} grams of lithium, and 10^{-11} grams of strontium could be detected. J.L.G.

Different sources of error in silicate analysis. WERNER MYLIUS. *Glashütte*, **62** [45], 782–86 (1932).—The paper deals with (1) critical considerations of a series of silicate analyses taken from the latest technical literature, (2) general errors in silicate analyses, and (3) some special determinations and their errors. M. points out the necessity of developing more exact analyses for determining up to 0.01% without difficulty. M.V.K.

"SeizO_2," an oxygen absorber. HAYS CORP. *Power*, **76** [4], 212 (1932).—For the absorption of oxygen in gas analysis a stable alkaline solution has been prepared which is unaffected by light and is claimed to absorb 47 times its volume of oxygen or four times the capacity of pyrogallic acid solution. F.G.H.

Use of nonaqueous solvents in study of the rare earth group. B. S. HOPKINS AND L. L. QUILL. *Proc. Nat. Acad. Sci.*, **19** [1], 64–68 (1933).—Ethylene glycol can be used to separate lanthanum and neodymium chlorides. Ether was used to separate neodymium nitrate from praseodymium nitrate. J.L.G.

Boron compounds in the ceramic industry. ANON. *Chem. Trade Jour.*, **92** [2382], 19–21 (1933). M.V.K.

Separation of titanium from aluminum and other elements by means of guanidine carbonate in tartrate solutions. A. JÍLEK AND J. KOTA. *Collection Czechoslo. Chem. Communications*, **4**, 412–17 (1932).—To the solution containing not over 0.1 g. of TiO_2 or 0.1 g. Al_2O_3 as sulfates, add 50 cc. of NH_4 tartrate prepared by neutralizing 2% tartaric acid with NH_4OH, make nearly neutral to methyl red with NaOH, add 75 cc. of a filtered 8% guanidine carbonate solution, dilute to 400 cc., and boil gently for 5 min. Filter and wash with about 100 cc. of a solution which contains in 400 cc., 75 cc. of 8% guanidine carbonate solution and 50 cc. of the NH_4 tartrate solution. Finally wash with 1% NH_4NO_3 solution until free from SO_4^{--}, dry, ignite, and weigh as TiO_2. In the filtrate determine Al as usual after decomposing the tartrate by evaporation with concentrated H_2SO_4. This method of precipitating Ti also succeeds in the presence of CrO_4^{--}, WO_4^{--}, MoO_4^{--}, or UO_2^{++}. See also *Ceram. Abs.*, **11** [11], 594 (1932). (*C.A.*)

Titration method for determining total and exchangeable bases in soils. S. PARAMESWARA AIYAR. *Indian Jour. Agric. Sci.*, **2**, 225–41 (1932).—A simple method is described for determining the total exchangeable bases in soils. The soil is leached with approximately 0.05 *N* HCl, and the leachate is titrated for acidity and total chloride. The difference between these titrations corresponds to the chlorides of Ca, Mg, K, and Na. The bases present as carbonates are corrected for by a CO_2 determination. Various indicators suitable for the titration were tested, and the condition for the accurate alkalimetric titration of the chlorides of Fe, Al, and Mn was determined. Data are presented to show the nature of the agreement obtained by different methods for the estimation of Mg, K, and total bases. (*C.A.*)

Adsorption by pure carbon. I. An interferometric investigation of adsorption by pure carbon from nonaqueous binary systems. F. E. BARTELL AND C. K. SLOAN. *Jour. Amer. Chem. Soc.*, **51**, 1637–43 (1929).—The interferometric method is used to measure the adsorption by pure C of α-bromonaphthalene, benzene, and ethyl carbonate from dilute solutions in EtOH. The adsorption tends to be in the same order as the

adhesion-tension values of these same solutes (as pure liquids) against C. **II. Adsorption by pure carbon from nonaqueous binary systems over the entire concentration range.** *Ibid.*, **51,** 1643–56 (1929).—The interferometric method is employed to measure the adsorption from various nonaqueous binary systems. An equation is developed representing the preferential adsorption over the entire concentration range, being based on the assumption that the adsorption of each component follows the Freundlich equation. The importance of measurements of adhesion-tension values is pointed out, and the Gibbs principle restated in terms of adhesion tension rather than interfacial tension. (*C.A.*)

Adsorption by silica from nonaqueous binary systems over the entire concentration range. F. E. BARTELL, G. H. SCHEFFLER, AND C. K. SLOAN. *Jour. Amer. Chem. Soc.*, **53,** 2501–2507 (1931).—At some portion of the concentration range each component of a binary system is preferentially adsorbed but that component having the higher adhesion tension is preferentially adsorbed over the greater portion of the range. The adsorption curve for SiO_2 is the inverted and reverse form of that obtained for carbon for the same liquid system (see preceding abstract). S-shaped curves are obtained when the data are plotted. (*C.A.*)

Photoelasticity. A purely optical method of determining deformation of specimens without imposing condition of parallelism. V. TESAR. *Rev. d'Optique*, **11,** 97 (1932).—Purely optical methods, based on the action of delicate mechanical contacts as proposed by H. Favre (*ibid.*, **8,** 193 (1929)) and C. Fabry (*Compt. rend.*, **190,** 457 (1930)), necessitated a good degree of parallelism between the specimen faces. In the present method, where comparison is made between each surface in turn and an echelon plate, the latter being suitably inclined to form a sheet of air with the specimen, such parallelism of faces is not essential. Deformation can be calculated from the birefringence (determined by the goniometer method of H. L. Tardy, *Ceram. Abs.*, **9** [2], 90 (1930), to an accuracy of $^1/_{100}$ wave-length), from Young's modulus, and from Poisson's ratio. The following are inherent advantages: (1) observations can be made on the entire specimen; (2) orientations of etalon for loaded and unstrained condition of specimen plate are independent. This method is complementary to that of Mesnager while the apparatus is simple and readily assembled. A photographic method of observation can be substituted. Details and diagrams of the apparatus incorporating these principles are given. (*J.S.G.T.*)

Determination of cobalt by nitrosonaphthol. C. MAYR AND F. FEIGL. *Z. anal. Chem.*, **90,** 15–19 (1932); *Analyst*, **57,** 739 (1932).—The process provides a better separation from Ni and Al than electrolysis. H.H.S.

Determination of titanium. E. KAHANE. *Jour. pharm. chim.*, **16,** 194–202 (1932); *Analyst*, **57,** 728 (1932).—To the slightly acid solution, Na thiosulfate is added, and the whole is poured into 400 cc. of boiling water. The precipitate of Ti hydroxide and sulfur is washed and ignited to TiO_2. H.H.S.

Separation of aluminium as phosphate in the presence of calcium phosphate. A. G. C. GWYER AND N. D. PULLEN. *Analyst*, **57,** 704–707 (1932).—Al phosphate can not be obtained free from Ca unless the p_H is more acid than 4.5. H.H.S.

Fluorides of carbon. P. LEBEAU AND A. DAMIENS. *Compt. rend.*, Nov. 17, 1930; *Internat. Bull. Refrig.*, **12,** 283 (1931).—F heated with C gave a mixture of several carbon fluorides, of which about half was CF_4, b. p. −188°C, m. p. −191°C. H.H.S.

BOOKS

Chemical Analysis by X-Rays and Its Applications. GEORGE VON HEVESY. xi + 333 pp. + 28 plates. McGraw-Hill Book Co., Inc., New York. $3.00. *Nature*, **131** [3298], 39–40 (1933).—The first chapters discuss the nature and production of X-ray spectra. For qualitative analysis, the presence of lines corresponding to the characteristic wave-lengths of an element imply the presence of that element. Quantitative determinations are more difficult. Full details are given on how to make an accurate quantitative determination of very small quantities. In the analysis of minerals, a concentration of one part in ten thousand can be determined. In more favorable conditions, such as exist in the determination of titanium in iron, a much higher sensitivity can be obtained. A method of analysis by the use of secondary X-radiation is described. The latter part of the book deals with the application of X-ray analysis to special problems. J.L.G.

Spirit of Research. T. BRAILSFORD ROBERTSON. xiv + 210 pp. 2 plates. F. W. Preece & Sons, Adelaide, Australia, 1931. 8s 6d. *Nature*, **131** [3300], 111–12 (1933). J.L.G.

PATENTS

Manufacture of stannic chloride. W. J. BUTTFIELD (Vulcan Retinning Co.). U. S. 1,897,360, Feb. 14, 1933.

Preparation of titanium oxide. J. BLUMENFELD. Brit. 385,315, Jan. 4, 1933.

General

Presidential address, 1933. EMERSON P. POSTE. *Bull. Amer. Ceram. Soc.*, **12** [2], 41–48 (1933).

John Clyde Hostetter, 1933 President. ANON. *Bull. Amer. Ceram. Soc.*, **12** [2], 50–52 (1933).

Standard classification of feldspar. B. C. BURGESS. *Bull. Amer. Ceram. Soc.*, **12** [2], 57–58 (1933).

Characteristics and control of silicosis. ANON. *Foundry*, **60** [14], 17 (1932).—Consideration of the dust hazard in industry formed the theme of the Nov., 1932, session of the National Founders Assn. It was shown that factors governing silicosis are (1) the percentage of dust in the air, (2) the size and number of particles, (3) the length of exposure, and (4) the susceptibility of the person exposed to the hazard. In the majority of instances the disease is incurred after exposure of 5 to 10 years and reasonable safety may be assumed in periods of 2 to 3 years; for safety it is recommended that workmen be not exposed to severe conditions for more than 1 year. No recognized limit of dust concentration has been established. The minute particles are the dangerous element, however, and it is assumed that the harmful particles fall in the range of 10 microns or less. Various methods of control are presented and the status of legislation upon the subject is discussed. F.G.H.

Theory of drying. J. FRITH AND F. BUCKINGHAM. *Engineering*, **134**, 460–63 (1932).—The methods available for drying different materials are compared. The theory of the wet-bulb thermometer is considered in detail and theoretical relationships are compared with the experimental results of Awbery and Griffiths (*Ceram. Abs.*, **11** [6], 379 (1932)). Its application to the problem of drying is considered. The wet-bulb temperature is a measure of the total heat per unit mass of the wet air. (*B.C.A.*)

"Robot" boiler-feed regulator. ANON. *Mech. World*, **93** [2402], 31–32 (1933).—A new feed-water regulator responds quickly to changes of boiler water level caused by changes in demand, thereby assisting steaming on increasing load and the absorbing of excess furnace heat on a falling load. It maintains constant level at steady load. E.P.R.

Significance of efficiency in power plant economics. THEODORE MAYNZ. *Power Plant Eng.*, **36** [20], 804–805 (1932).—Savings in fuel may be an economic waste if purchased at too high a price. A method is given for calculating allowable investment. E.P.R.

Relative fuel economy of heating agents. A. H. BARKER. *Mech. World*, **92** [2397], 552 (1932).—B. explains the conditions in which electrical power can be used competitively for heating buildings in spite of the fact that the cost of the crude heat is several times greater than that of any other heating medium. The cost of the fuel and the labor inevitably incurred in handling it, and not questions of capital cost and allied matters, are discussed. E.P.R.

Power from refuse. E. W. SMITH. *Mech. World*, **92** [2394], 488 (1932).—The plant at Huddersfield has high-pressure blast-furnace type incinerating cells working in conjunction with a water-tube boiler and saving 8000 tons of coal. E.P.R.

Figuring the capacities of tanks and boilers. C. R. CHADBOURNE. *Power*, **76** [3], 158 (1932). F.G.H.

Boiler feedwater softening. W. J. RYAN. *Power*, **76** [3], 144–46 (1932).—R. outlines the operation of zeolite and hot-process lime-soda softeners, pointing out the advantages and limitations of each. Illustrated with diagrams. F.G.H.

Cleaning low-grade clays. M. C. SHAW. *Ceram. Age*, **20** [6], 220–21 (1932).—S. reports results obtained in an investigation of the Roseville branch of the Ohio State Engineering Experiment Station. R.G.M.

Meeting of the Kaiser-Wilhelm Institute for silicate researches. HANS KÜHL. *Glashütte*, **62** [47], 833 (1932).—K. discusses a series of reports read at the meeting held in November, including those by (1) L. Forsen, "The constitution of hydrates of calcium aluminates," (2) B. Gruen, "Hydration processes occurring in cement," (3) W. Buessem, "Quantitative crystal analysis; X-rays in determining free lime in compounds of the $CaO \cdot Al_2O_3$ system," (4) Salmang, "Dilatometric measurements of glasses," (5) Möttig,

"Behavior of oxides forming glass under high pressure of oxygen," (6) Kiltz, "Temperature dependence of absorption in colored glasses," (7) Weyl, "Constitution of glasses," and (8) Harkort, "Characteristics of clays and their mineralogical analysis." M.V.K.

Statistical methods in industry. ANON. *Nature*, **130** [3287], 652 (1932).—The value of statistical methods in industry, *i.e.*, their value in promoting efficiency of methods of production and improving the quality of the thing produced, is just beginning to be realized. W. A. Shewhart of the Bell Telephone Laboratories gave three lectures in England in May, 1932, on the "Rôle of Statistical Theory in Industrial Standardization." He is chairman of a committee on the development of statistical applications in engineering and manufacturing, sponsored jointly by the A.S.M.E. and the A.S.T.M. The British Standards Institution, before whom the address was given, has appointed B. H. Wilsdon, of the Department of Scientific and Industrial Research, Building Research Station, chairman of a committee to investigate the problem from the point of view of standardization and specification. Similar action has been taken by the Deutscher Normenausschuss in Germany. Pearson, of the Dept. of Applied Statistics at the University College, London, contributed a paper on statistical methods in quality control of output at the York meeting of the British Assn. The Biometric Laboratory at University College, London, would seem well equipped for the development of education and research in this particular line. J.L.G.

Budgeting research. H. N. SOLAKIAN. *Research Lab. Rec.*, **1** [3], 89–91 (1932); abstracted in *Mech. Eng.*, **54** [5], 382 (1932).—The proper amount to be allowed for research is considered. Factors determining a budget for maintaining a research laboratory or organization are discussed. F.G.H.

Ceramic industry and the progress accomplished. G. COLIEZ. *Ind. chimique*, **19** [227], 917 (1932); for abstract see *Ceram. Abs.*, **11** [7], 424 (1932). M.V.K.

Technical education and progressive industry. ANON. *Nature*, **130** [3295], 941–43 (1932).—The article is a digest and discussion of a report made by two Board of Education Inspectors, A. Abbott and J. E. Dalton, on the relation of technical education to industry in Great Britain. Continental countries give a severe practical training to recruits before they enter industry. In Great Britain, technical education is built on the basis of part-time instruction of the worker after he enters industry. The inspectors find that there is a definite planning of technical education needed for the needs of industry and society as a whole, rather than to meet individual requirements and ambitions. With this in mind, it is recommended that night-school instruction be replaced by a system which involves less strain on the student and yields better results. J.L.G.

Wage incentives for the smaller industries. STEWART M. LOWRY. *Better Enameling*, **4** [1], 13–14 (1933).—L. discusses the possibilities of wage incentives for employees in the smaller industries. Examples of incentives and standardization of performances for the purpose of applying the wage incentive plan are cited. At the conclusion, the incentive plan is summarized. See also *Ceram. Abs.*, **12** [3], 133 (1933). W.W.M.

Ceramists of New Jersey in fall meeting. ANON. *Ceram. Age*, **20** [4], 173–75 (1932). R.G.M.

BOOKS

Ten Years of Industrial Psychology: An account of the first decade of the National Institute of Industrial Psychology. HENRY J. WELCH AND CHARLES S. MYERS. ix + 146 pp. 9 plates. Isaac Pitman and Sons, Ltd., London, 1932. 6s net. *Nature*, **130** [3286], 610–11 (1932).—The book is an account of the activities of the National Institute of Industrial Psychology for the first ten years of its life since its founding in 1920. Its work has been the investigation and improvement of actual working conditions and methods in factories and offices; the study of personnel organization, including methods of selecting staff, training promotion, and incentives; and the giving of vocational guidance based on the physiological and psychological study of abilities and temperamental qualities of workers. J.L.G.

Marlborough's German Technical Words and Phrases Dictionary. E. M. ROLFFS. Published by E. Marlborough & Co., Ltd. *Concrete Constr. Eng.*, **27** [7], 398 (1932). F.G.H.

Hoyer-Kreuter Technical Dictionary. A. SCHLOMANN. *Power*, **76** [3], 159 (1932); for abstract see *Ceram. Abs.*, **12** [3], 133 (1933). F.G.H.

Employees' suggestion systems. METROPOLITAN LIFE INSURANCE CO. *Foundry*, **60** [14], 70 (1932).—This booklet discusses methods used by representative industrial companies to obtain worthwhile suggestions from their personnel. The report is based on a study of systems of more than 100 organizations and describes outstanding features of the various plans. F.G.H.

Industrial Management in This Machine Age. F. A. WESTBROOK. Published by Thomas Y. Crowell Co. 407 pp. Reviewed in *Foundry*, **60** [14], 54 (1932).—The principles and scope of scientific management are discussed under the following topical divisions: (1) scientific research and technical control, (2) planning for growth, (3) research applied to sales, (4) organization of the sales department, (5) organization and functions of the engineering department, (6) organization of the purchasing department and production control, (7) layout of plant for production, (8) plant maintenance, (9) inspection, (10) costs, and (11) mechanical handling. Numerous charts add to the value of the work. F.G.H.

Law of Patents for Chemists. J. ROSSMAN. *Nature*, **131** [3300], 115 (1933); see also *Ceram. Abs.*, **11** [10], 546 (1932). J.L.G.

Book Review

Pocketbook for Ceramists, 1933. Vol. I. Notebook-calendar with 18 pp. text. Vol. II. Technical part 320 pp. Published by Keramische Rundschau, Berlin. Price 3.30 M. The booklet is appearing for the 25th time. Due to its valuable and constantly changing reading matter, it has gained a steadily increasing circle of users. The text is introduced by a comprehensive article on "The technic of decorating fine ceramics, glassware, and enamel." The essentials have been well selected and presented. Information on modern decorating practices is given in full. The professional man will welcome the booklet because of its references to literature. It also contains a section on legal protection pertaining to the trade, a comprehensive list of supply firms, a bibliography, and many tables. The chapter on "The classification of clayware" is noteworthy. The calendar and tables of general information are presented in a separate booklet. T.W.GARVE

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of the

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Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

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EDITORIAL

HOW TO VALUE OUR SOCIETY

The value of our *Journal* is appreciated by its readers. Those who do much technical research consider its papers and abstracts to be excellent and worth much more than $10.00 a year. The *Abstracts* which are condensed, carefully checked, and edited, make available each month the printed ceramic literature from all over the world. The intrinsic value of this service to those who wish to keep up with ceramic progress can not be stated in monetary terms. These *Abstracts* alone are worth immeasurably more than the entire expense budget for our Society activities.

But as valuable as the *Journal* and *Abstracts* are at the present time, they could be improved and enlarged if the Society had larger financial support. Our *Abstracts* could be more thoroughly presented, more informing, and more timely.

We should issue a Collective Index for the first ten volumes of the *Journal* and eight volumes of the *Abstracts* and *Bulletin*, published from 1918–1927. This index would be worth much more to our members than the estimated $5000 cost for compilation and printing. But even for such an informing and time-saving publication to our members, this index can not be undertaken at the present time.

Bibliographies on specific subjects have been requested because of the value of those which the Society has already published, especially on enamels and refractories. But in addition to the printing costs there are other heavy expenses in connection with issuing bibliographies. The printing cost of the Enamel Bibliography was met almost entirely by underwriting subscriptions and the costs of the Refractories Bibliography by

subscriptions and advertisements. In neither case was the cost of editing covered by underwriting, advertising, or sales. The editing costs were met from the general operating funds of the Society.

A Ceramic Book List is being compiled. It will be expensive in time, material, editing, and printing, but it is badly needed by ceramists all over the world.

Committee reports are being prepared which epitomize the latest data, and methods and funds are needed to give these adequate publicity.

Our Activities

Collaboration with other societies develops new inspiration and facts. This activity places this, your coöperative enterprise, in a commanding position of influence on all questions regarding the use of ceramic products.

We are collaborating to a limited extent, but not as much or as aggressively as we must if we, the producers of ceramic products, are to keep up with the competitive products. It would cost more than the Society's present income could permit to collaborate with other societies as fully as we should be doing.

Our Society is designed to be the means by which ceramic manufacturers foster and influence ceramic education and research in schools, laboratories, and federal and state research bureaus. Much has been done in this respect, but many more possibilities are visioned. When the Society's financial resources will permit more extensive work, there will be larger returns from the tax investments which we, as individuals and as firms, are making in our schools and public laboratories. They are supported by the taxes we pay, and they serve most effectively those industrial interests which cultivate them the most.

There are many ways and means by which this Society could be aiding in modernizing our knowledge of how ceramic manufacturers can "hold the pole" in competition with other products.

This Society is doing more than the present income permits, largely because individual members are giving generously of their time and money on specific projects. They are setting a pace which calls for a budget larger than our present income will cover for general operations, publishing, and organizing.

In brief, we are face to face with the necessity for doing more than we are now doing. The pace has quickened, but our Society's capacity to do and to motivate has not increased with the increasing demands.

We should have annually $20,000 more than we have at the present time.

Two thousand new members at $10 per year? Is that too much to expect?

How about 1000 corporations at $25.00 per year? That seems more feasible. Let's try to get them.

How about more advertising in the *Journal?* Will you help to obtain it? Write a "cheerio" to those who are advertising and send a contract blank to those who should be advertising; at least send their firm name and the name of their sales manager to offices of the Society.

Let them know that the purpose of this *Journal* is not direct financial profit, but the advance of the ceramic arts and sciences. It is a ceramic publication that goes to those who make the purchasing decisions.

What do you say about increasing the corporation dues to $50.00 per year? Let's hear from you on this proposal.

No matter what our methods or means we should gird ourselves for the task of meeting the increased demands that are ours. Will you help? Let us hear from you.

PAPERS AND DISCUSSIONS

RESEARCH AND HUMAN WELFARE

By Emerson P. Poste

Editor's Note: This Symposium on Research was presented at the General Session on Monday, February 13, 1933, at the Annual Meeting of the American Ceramic Society, Pittsburgh, Pa.

In his book, Science as Revelation, John M. Watson develops the theme that the cosmos is permeated by an infinite personality whose processes are manifest in every phase of existence. After amplifying this idea in terms of various branches of knowledge he states "that science finds all things that are known to exist on the earth or throughout the universe have been produced by the expenditure of energy." He proceeds to term this general conception the "New Religion" and states "The New Religion recognizes, and indeed is elated over, the harmony of the cosmos, the perfect, orderly, lawful system that prevails throughout the universe." After pointing out the folly of man's attempts to ignore or combat this principle he goes on to say "The New Religion, therefore, recognizes and stresses the need of cosmic coöperation on the part of men. The very highest and best thing that man can do is to put forth his supremest effort to understand the systems of laws that form his environment and to do his part to coöperate with them."

Robert A. Millikan, in his essay on Science and Society, makes an interesting social application of this theme as follows:

> The supreme question which the present generation faces is—Can we make democracy work, not merely for America, but for the world? Can we replace bullets by ballots?—If an affirmative answer is found it will be because the nations of the earth, including our own, learn to take a more rational, a more objective, a more scientific attitude toward life and all its problems than any of them as yet have learned to take.

The same authority takes a step nearer to the topic of the day when he states that "public-spirited men are going to see more and more that support in a large way of scientific research is an investment which brings the largest returns of satisfaction to themselves and of progress to mankind which can be made at all."

Much of the progress which man has made has come through his success in recognizing and acting on the fundamental facts of his experience, and coördinating his observations as a means of better adapting himself to his environment. Without discrediting the labors of earlier philosophers, but little progress was made until the inductive method of reasoning was employed by Bacon and his successors and the term "research" as used today can not be applied to the work of investigators till relatively modern times. As an approach to the consideration of "coördinated research" it may not come amiss to review certain developments which have been outstanding in their contributions to the welfare of modern society.

The classic instance of the application of certain scientific facts to the benefit of humanity at large is the work of Louis Pasteur. Starting with the discovery that fermentation is caused by the action of certain microörganisms, that the course of fermentation varies with different organisms, and that in the absence of organisms fermentation does not take place, he applied his ideas to a variety of situations and became the founder of the science of bacteriology. The term "spontaneous generation" had been used to explain the decomposition of organic matter and the origin of certain diseases. Pasteur showed that foods could be preserved by eliminating bacteria; that various diseases of beast and man were due to the action of germs and could be controlled

by bacteriological methods: and in coöperation with Lister and other surgeons he waged the battle against infection which has resulted in the surgical technique of modern days. The coördinated application of a scientific principle in manifold phases of life thus produced a tremendous benefit to human kind.

The field of organic chemistry affords an example of the use of a fundamental idea as the foundation of a radical development. Until the advancement of Kekulé's theory of the structural nature of the aromatic compounds based on his conception of the constitution of the benzene ring, little progress was made in that branch of chemistry. But with this theory as a tool other workers were able to develop structural formulas and as a result synthetic organic chemistry with its medicines, dyestuffs, explosives, and other compounds is today one of the most valuable servants of man.

The science of physics affords numerous examples of man's efforts to determine the nature of matter and to apply this knowledge to our modern life. It is only necessary to mention the fields of radio-activity, X-ray, vacuum tubes, and the like, to remind us of the pure and applied research which has been carried out in these fields.

Metallurgy was a rule-of-thumb art until the work of Sorby, Stead, Roberts-Austin, and others in Europe, and Sauver, Howe, and their contemporaries in America led to the science of metallography which treats of the structural components of metals and alloys in the light of equilibrium diagrams. Based on this foundation our tool and alloy steel development has taken place to say nothing of an understanding of the other ferrous as well as nonferrous metals. Few branches of endeavor deserve more credit for the development of our machine age.

We have thus reminded ourselves that we live in an orderly environment, subject to systems of laws, whether we wish it so or not. We have reviewed certain of man's accomplishments in becoming acquainted with and conforming to these laws. We have endeavored to indicate that much of this progress has been based on the coöperative application of certain basic principles to various phases of given lines of interest. We may now ask ourselves a question as to whether the silicate industries have kept and are keeping pace with their possibilities in the execution and interpretation of research. Are we making proper application of the fundamental sciences to the manufacturing of ceramic products? Are our various research agencies properly motivated and coördinated for the greatest good to all concerned? It is indeed fitting that we should devote this, the first session of our 1933 Meeting, to a consideration of this problem.

In so doing it behooves us to become inspired and better informed by a clearer idea of what is being done by the National Research Council in general and certain industries in particular. To this end we have been able to arrange an address by an executive of the Council. It is also well that we catch the gleam from one of our own members who, as an executive in a branch of our industry, has a particularly keen vision of the merits of our theme. And finally we should know of the work and ambitions of our own Committee on Research, based on the study of the case which the Committee has made this year.

RESEARCH—A FACTOR IN COMPETITION

By William Spraragen

Is your company insured against fire? Foolish question, most of you would say. Nevertheless I am willing to wager that during the past decade more companies have been destroyed by lack of industrial insurance, called "research," than have been by fires. Today there is no industrialist of importance who has not accepted research with enthusiasm or reluctantly admitted that his science-minded competitors are laying profane hands on the methods of his grandfather. Usually this tragedy is written in red ink. Research is truly an insurance against the scientific surprises of rivals and naturally leaders of industry want to take out such an insurance policy. Eleven years ago the existence of less than 500 industrial research laboratories maintained by commercial industrial concerns was recorded in a bulletin issued by the National Research Council. A revised edition, published two years ago, contained more than 1600 of such laboratories.

In addition to the scientific output of these laboratories there is an ever-swelling tide of new applications of science coming from the numerous technological institutions and colleges and the university schools of engineering.

How is research going to affect the ceramic industry? That is a question which perhaps you know better than I do. I am sure that the speakers that follow me will have something to say on this point.

I do know, however, that at the moment some enterprising paper laboratories and chemists playing around with plastics are planning to divert some of the consumers' dollars now going to the ceramic industries into their own pockets. In fact, I believe they will be partially successful. Before some of you become violent at this thought let me remind you that some of the headlines in scientific magazines indicate that certain of your own investigators are even now at work in taking away the business of some other fellows who are not so well armed with research talent.

A little later I shall read you a few of the items that I have noted in the scientific magazines since I was asked to prepare this brief address before your Society.

The New Competition

Present-day competition is between different industries as distinguished from the old competition which was only among the several firms of the same industry. Research has made it possible for a totally different industry to compete successfully for part or even all of the business of some other industry.

This new competition has necessitated coöperation among former competitors of the industry threatened. This coöperation usually conducted through the facilities of trade associations takes the form of coöperative research, advertising, and marketing. Coöperative research is best undertaken on problems which are common to a number of companies. This eliminates unnecessary duplication, reduces the cost of the investigational work to any one company, and, moreover, by combining the experience and knowledge of a number, tends to increase the chances of a successful solution. Other studies involving investigational work over a period of years or dealing with matters of public relations or welfare should be conducted by the association. On the other hand, research which relates to patentable discoveries, special processes, and items of a similar nature can be best carried out by the individual companies.

Research in the Depression

How has research fared in these lean years? The National Research Council has secured data from some 400 companies representing 20 industries. Of these companies 51.3% increased their research expenditures in 1931 as compared with 1929, 18.7%

made no change, leaving only 30% that decreased their appropriations for research. Translated in percentage of sales the figures become still more startling as fully 91% of the companies made no change or increased their percentage of sales devoted to research as compared with 9% that decreased such expenditures.

It is surprising that relatively the effectiveness of the smaller company in the research battle was as great as the larger companies. Another significant fact brought out in this study is the flexibility of research as a business aid. In 1928 the research tool was largely used to lower costs of production. In 1931 efforts were concentrated to develop new products and improve quality. In the ceramic industry eight companies replied to the questionnaire of which five increased their research expenditure in 1931 as compared with 1929 and three decreased. Translated in percentage of sales we find that only one devoted a smaller percentage of its sales income to research; of these companies three were spending less than $10,000 a year on research and the other five were spending from $10,000 to $100,000 annually. Instead of turning their attention to the development of new products as was the case of many other industries, the ceramics group, or at least the companies reporting therein, devoted their major attention in the reduction of production cost and improvement of quality of product.

We asked these companies whether they might be affected by future technical developments. All of the companies from the ceramic industry were positive that they would be so affected. All of them had produced new products which have been commercialized during the past two years and nearly half have made technical developments which were useful to other industries. More than 80% of the companies reporting in the ceramic industry were spending between 1 and 5% of their income on research. The remainder were spending less than 1%. So much for research in the depression. I have statistics on each of the important industries which I shall be glad to supply to those who are interested.

Research and the Investor

In a recent study of the 852 firms whose stocks are listed on the New York Stock Exchange, 224 were found to have laboratories which were included in the bulletin mentioned above which lists sixteen hundred research laboratories. This represents more than 26%. If we include those companies which make use of other outside research facilities (university, consulting, or government) and eliminate the purely merchandising and holding companies, the percentage becomes still larger.

To carry the matter farther, a survey was made of the latest annual reports of these 224 companies, and it was found that 56 or exactly 25% devoted a portion of their annual report to some mention of their research activities. These references vary from a few sentences to several pages. This indicates the position research has attained as one of the fundamental industrial factors to be reported on to stockholders along with finance, markets, operations, labor conditions, general business conditions, and outlook for the future.

New Products

We asked some of the companies replying as to what they thought might be some developments in the ceramic industries. Here are a few typical items: Electric heating in ceramic industry, automatic machinery, artificial stone and metal coating, plastic sheetings, and stainless metals. As indicated in my opening remarks, when I agreed to present this address I made a mental note to jot down references in such scientific papers as passed over my desk in the interval which might contain items of interest to some of the members of your Society. Here are a few of these items:

Silica Black, a New Product of Many Possible Uses: Black coal and white earth mix to produce something blacker than the original coal.

Metallic Powders Pressed into Light, Useful Objects: The process is similar to that used in making some clay and porcelain products.

Better Spark Plugs Sought on Lonely Mountain Peak: This announcement was made by F. H. Riddle at a meeting of the American Institute of Mining and Metallurgical Engineers. The rare mineral, andalusite, has the same chemical composition as sillimanite which has the strength of two to four times that of normal porcelain with improved heat-shock resistance.

Treatment with Heat Affects Quality of Optical Glass: Scientists have found that the exact control of temperature during annealing process has much more to do with the quality of glass than has been previously thought. For example, they have shown that an inferior piece of optical glass may possibly be reclaimed by reannealing, or tempering with heat, at exactly the proper temperature.

Invisible Glass for Store Show Windows: The secret is to curve the surface of the glass pane so that reflections of objects in front of it are not seen. Free from these reflections, the glass becomes virtually invisible.

A Remarkable New Glass: An organic glass named Pollopas was recently invented in Vienna. The outstanding characteristics are perfect transparency and unusual strength. It does not break or splinter. Its specific gravity is that of half of glass. In its dispersion properties Pollopas stands close to rock crystal. Its mechanical properties are excellent. It is transparent to ultra-violet light. It can be brilliantly colored by direct dyes used on cotton. It lends itself to the production of imitations of semiprecious stones and porcelains in all colors, smokers' and travelers' requisites, billard balls, door knobs, lamp shades.

Glass Blackboards: These are blacker than slate and more free from defects in manufacture. An abrasive suspended in the molten glass makes it take the chalk.

Glass Brick: These are translucent, admitting light, but are not transparent, as ridges in the brick prevent one from seeing through them and also act as prisms to gather light. They have a crushing strength superior to clay brick.

Glass Replaced by Steel in World's Largest Radio Tube.

Metal Strips Waterproof Brick Walls Permanently.

Iron Chunks Blown up Like Puffed Grain in New Process.

New Research Tools: New research tools are constantly being developed for temperature and pressure control. Some of these developments might bring about revolutionary achievements in the ceramic industry.

Our British friends are also at work. In a report of the Economic Advisory Council Committee on New Industrial Development I find the following quotation:

An example of a different kind is the improvement in the behavior of "saggers," for which the Refractories Research Association is responsible. Saggers are the fireclay containers in which most classes of pottery and porcelain are placed to protect them from the direct effect of the fire. As the result of suggestions made by the Research Association, one manufacturer has declared that the life of saggers used in his works has been increased from about 7 to over 200 firings, and that, in consequence, his Sagger Department had temporarily to suspend its operations. As it is estimated that at the present time about £200,000 per year are spent in the replacement of saggers, the economies which will be achieved by means of this improvement are obviously very substantial.

Research in the Welding Industry

When I accepted the task of presenting this address I was delighted to find that your President, E. P. Poste, was to be the presiding officer. Mr. Poste and I had some contacts a number of years ago in the matter of coöperative research in the welding industry. The particular investigation dealt with pressure vessels and was conducted by the American Bureau of Welding which is the Research Department of the American Welding Society and is also affiliated with the National Research Council.

When the Bureau was first organized there was a complete lack of knowledge of the fundamentals of welding engineering. The Bureau found it advantageous to confine its first efforts to standardization of methods of testing welds, of preparing specifications

and of laying out suitable courses for the training of operators. As the processes became more standardized it turned its attention to securing fundamental design data which were needed by the industry, and with a solution of these more practical problems it has now undertaken the study of the fundamentals of welding. This perhaps indicates a desirable procedure for a new industry. An argument not usually advanced for such coöperative research is the creation of good fellowship among competing companies. It so happens that in the welding industry this matter of fellowship and coöperation was particularly important. Lack of public confidence in the product of this industry was the greatest handicap at the outset. This was largely overcome by maintaining a high quality of product through research and standardization.

Some fifteen years ago welding was relatively little known and used in minor repair work. Today its applications are almost universal in extent ranging from the smallest watch stem to huge locomotives, skyscrapers, and welded ships. It is now ranked among the leading industries of the United States. This is certainly proof of what can be done through coöperative effort.

As an example of a practical investigation there is cited the work of the Structural Steel Welding Committee of the Bureau. This Committee secured the coöperation of 39 fabricating shops, 24 testing laboratories, and 3 steel mills in the testing of several thousand specimens in order to secure fundamental design data. The results of this investigation have led to the adoption of welding in the building codes of more than 125 cities and municipalities. The work of the Bureau is financed by contributions of cash and services from industry as may be needed for specific investigations.

The fundamental research work is carried on in various educational institutions scattered over the United States. The Bureau assists in the formulation of problems selected for study, in supplying specimens as may be needed under conditions required by the laboratory, and also in furnishing apparatus and funds where needed. Each university undertakes some fundamental problem with only a few variables which it can control. Although started in many instances with no commercial application in mind, many of these fundamental studies have been of far-reaching importance to the industry.

Research in the Foundry Industry

A number of years ago representatives from the foundry industry came to the National Research Council with a suggestion that research be conducted as to the possibilities of the re-use of molding sands thus saving initial costs of sands and handling charges.

After continued conferences with the research leaders it was agreed that the first step was to standardize methods of testing molding sands. Before that time the quality of the molding sand was in a large measure dependent upon the "feel" of the expert operator. Much to the surprise of some of the practical men it took more than one year to standardize on methods of testing desirable properties. Once this task was accomplished the rest of the problem was relatively simple. Through our contacts with State Geological Departments samples of molding sands were obtained from various parts of the country which were tested at selected centers. This resulted in finding 500 new desirable molding sand deposits and the need for reclaiming used molding sand was not so great although very good work was done in this direction for certain foundry operations.

Selecting Subjects for Study

This is a question which often arises in the minds of organizations desiring to conduct research. The selection of any program for study should be pursued with care. Some problems will be found to be of such a nature that they will yield results in a reasonably short time and thus provide against the possibility of condemnation by more impatient

members of an association. The program should include, if possible, problems of a fundamental as well as of a practical nature.

Before a project is undertaken certain yardsticks should be applied in the nature of the following questions:

(1) Is the project really important?
(2) What are the prospects of success?
(3) Has it been done before?
(4) Are the resources of time, money, and personnel available for successful completion?

It is desirable to lay out a suitable program of research with proper recognition of the time element involved for a probable solution of each problem. Some problems require for their complete solution a period of years and, unless careful financial provisions are made for completing the work undertaken, considerable sums of money may be wasted, since the preparatory work can seldom be translated into profitable use.

Some problems should be of such a nature that usable results may be obtained after a period of one year, others perhaps after a period of two years, and still others after three or more years. In this way continued confidence would result in the work of an association and particularly on the part of some of the more impatient members.

An association desiring to undertake research as part of its activities should make a thorough survey of the most important chronic technical problems hindering the progress of the industry as evidenced by the opinions of some of the key men of the industry and these should be given due consideration from the point of view of importance and of time element involved in their solution.

One of the great difficulties in conducting a research program arises from the temptation of every one with trouble of any kind to bring it to the laboratory for solution, thus turning the laboratory into a "trouble-shooting" agency rather than a research organization. Of course, some of the problems undertaken by the research laboratory may properly arise as a result of troubles, but it is undesirable that the entire program be given over to manufacturing problems rather than to actual research work. Some trade associations have two separate departments to take care of both types of problems.

From the foregoing you can readily see that the organization of coöperative research is a matter that requires a great deal of study. We have had experience in handling various types of research organizations, patentable discoveries, reporting results, utilization of the results of research, financing the cost of investigations, committee personnel, and other matters of a similar nature. For those who wish to inform themselves of practices that have been found useful in the conduct of private research laboratories I would refer you to a book recently prepared by the National Research Council and published by Harper and Brothers entitled Profitable Practice in Industrial Research. This book represents the accumulated experience of the past twenty-five years in American industrial research. In their own words, the directors of numerous great research laboratories have pointed out the paths which they have found to lead to success in research with the least possible unproductive expenditure.

One eminent scientist has said that applied science is neither more nor less than an investigation in the laboratory of the processes which are involved in the adaptation of Nature to the service of society in one form or another, a purpose which is surely eminently important and desirable. Some of these processes have been carried on empirically and with relative success for generations, to the great advantage of mankind. A large amount of experience has been accumulated and handed on by tradition, custom, and instruction, but such experience has not been critically examined by means of scientific methods and resources. So far as rules have been arrived at in this way, the experience acquired rests on what we may call rule-of-thumb. The purpose of applied science is to substitute the rule of scientific law for the rule-of-thumb.

In other words the research laboratory is a factory in which ideas are translated into physical things and those physical things are put in form to be made available to the public for that public's pleasure, profit, or convenience.

Research and the Nation

We have now passed through the experimental stage of adapting science to life and life to science. We know that substantial material advance in many directions can be hoped for only through industrial research properly organized, properly equipped with a selected scientific personnel, making proper use of new fundamental knowledge, and properly coördinated with all the other functions which experience has shown to be necessary in the conduct of life in the modern world.

There was a time in the history of mankind when new products or processes were discovered rather than invented. Men would stumble upon such discoveries, which probably surprised them as much as they did the rest of the world. But our scientists and technicians today are by no means groping about and hoping for some happy chance or sudden inspiration to reward their efforts. They set themselves very definite problems and they work along patiently until they have arrived at definite and satisfactory solutions. Research has made of invention a scientific, highly efficient process. Research, too, is continually giving us new uses for old products and is placing within the reach of the average American goods whose production cost was once prohibitive.

Conclusion

In conclusion I should like to urge upon the members of your Society, and particularly its leaders, to make a careful technical audit of your industry and the scientific elements thereof. Such an audit will undoubtedly reveal numerous gaps in basic knowledge, the securing of which will result in improved products, new fields of application, lowering cost of production, and development of by-products or new products. Some of this knowledge can be gained through coöperative effort. Other parts can be best secured by individual initiative. I commend both for your consideration.

Secretary, Division of Engineering and Industrial Research
National Research Council
Engineering Societies Building
New York, N. Y.

A PROPOSAL FOR CORRELATION OF CERAMIC RESEARCH

By J. M. McKinley

Whether or not the ceramic arts have produced, or can soon produce, an Edison or a Steinmetz might be made the subject of an interesting debate. The work of such men is evaluated finally in the activity of the Mr. Babbitts who surround or follow them, or by the brilliant applied research of a DeForest working over the pure philosophy of an abandoned Edison experiment. In the electrical field it is plain that something resembling a completed formula has been at work; on the one side the symbols of the Steinmetz mind, on the other those of Mr. Babbitt. Whether we are to have a balanced equation in the ceramic field, or merely a flock of isolated static models is of the utmost importance in the face of current and forthcoming industrial conditions. In prosperous periods a great amount of general research effort is almost sure to produce work of merit; in depressed periods the amount of such work falls far short of an arithmetical ratio if for no other reason than that the executive mind is liberal and otherwise engrossed in prosperity, but becomes intensely conservative in adversity, demanding an empirical program keyed to production and sales problems.

Tolstoy has implied that only the sufficient wisdom of the amateur permits him to spread his efforts in two divergent channels. The translator of Anna Karenina seems to have lost the gentle sarcasm of Tolstoy's remark; that sarcasm should not be lost upon us. There is no such division in the mine of the trained executive manufacturer's mind; his problem is that of dollars, and he devotes his entire time to making them perform, using a routine not unlike a Balkan player with a troup of trained bears. With only rare exceptions the technical mind is divided. In one very extensive group you find the university worker with a staff and student body confronting him more often than is good for real mental equilibrium. In another group is the research worker in the private or public laboratory who must divert fundamentally valuable time into control and development testing of a pure commercial character. Still another, and constantly increasing class appears, the director of research who also functions in sales engineering and even in direct production administration. These appear to be the conditions as we find them; Tolstoy may have been right, but knowledge of such a fact does not alter the premises in the case. We are inseparably a part of an industrial fabric in whose pattern no single feature of design can be altered except in the gradual alteration of the whole.

In view of the very nature of the ceramic art, positive conclusions as to progress are not easily drawn. Few, if any, of our other arts have the peculiar basic simplicity, and at the same time the baffling ultimate technique. If we are to regard our present research position as being inadequate, it might be well to look back. Within the memory and actual experience of many of us, ceramic manufacturers actually placed a premium upon ignorance. The enormous improvement in the last twenty years is perhaps best attested by the files of the *Journal of the American Ceramic Society*. If our present day manufacturers are placing a premium on mediocrity, the fact need not be unduly disturbing; we are not alone in this, nor will we ever perhaps see the day when mediocrity does not exist and exert by reason of its very mass a considerable effect upon all of the arts.

Before attempting an analysis of the research status which the art may create for itself, some comment is needed in regard to what may be called the employer attitude. It is not difficult to visualize the results possible could certain men enter the field of philosophy, after due training in both theory and practice; but this does not happen in whole, or even adequately in part. Commercial instincts at the root of the art persist through the whole structure as we know it today. It is not to the existence of these instincts that objection should be made, as they are necessary and natural; we do object

to the confusion of mind with regard to technical control and pure research. At the evident risk of controversy, it must be stated that the ceramic industries are badly organized in these fields. When it is said that a certain executive is "research minded" progress is being recorded; but actual complete attainment of the executive end can not be secured until he grasps the significance of this problem, and devises a clear separation of the two fields of endeavor.

This attitude may be due to failure on the part of the ceramic technicians to professionalize their work. Ultimately this will come, not alone in our art but in numerous phases of engineering where the need is almost as great. An interesting case is presented in the large modern corporation, both financial and industrial, where it is not uncommon to find a staff of lawyers to serve the routine requirements of the corporation; just as soon as a critical action is under review, these corporations invariably seek independent and highly professionalized counsel; the reason is plain enough: the independent lawyer has not alone a more varied experience, but he has had time to go deeper into the pure philosophy of the law, through which more than one great lawyer has colored or even dominated the court by the sheer force of reason. It requires little reasoning to conclude that ceramic research workers and engineers will reach eventually such a position, and every care should be taken to prevent the American Ceramic Society Fellowship from missing the real issue involved. The medium through which such an end is to be attained is less important than the constant presence of one clear objective.

Confusion in the employer attitude is in the end a product of two very definite factors, one the ever-present element of cost, and the other the manifest lack of clarity in nearly all of our technical organizations as to the relative positions of research, engineering, and control. In dealing with the first of these factors some sad platitudes might fit the case; after all, every technical effort is for sale, with only rare exceptions. If not directly so, these efforts at least are on the market in the form of the students leaving our schools each year. Not enough manufacturers are counting as fully necessary the cost of ceramic engineering. The answer in this difficulty is found in dealing with the second factor, namely, the lack of clarity in our technical organizations. To define adequately the fundamental requirements of research, engineering, and control facilities with the limits of permissible overlapping of functions, will be the work perhaps of years. A recent review of the general methods and mental attitudes of a number of trade association programs, school and university organizations, and private laboratory facilities revealed so great a divergence of thought and practice that it is impossible to codify even elemental considerations. The detail involved is confusing; and it must be admitted that each unit seems to express the individualistic tendencies of its own leadership. Strong personalities are a valuable asset, but they lose in value insofar as they offer resistance or at best show complacency in the face of a general situation which it would be hard to defend in some of its weak points. It is possible to have, and a survey shows that we do have, units of unquestioned value; others are being rapidly strengthened as units; but there does not yet exist any medium affording a centralized clearing house where the work may be welded into an effective whole. If research must be sold, then let it be given such a strong final coöperative approval that its value may be unquestioned, regardless of the amount of controversy that may be required to establish the facts.

Such a clearing house can not be contemplated until the necessary corrections have been made in the underlying structure. No other body exists with the qualifications of the American Ceramic Society, whose make-up needs no alteration whatsoever to enable it to bring this problem before those interested, and keep it there. The Society's Research Committee and its publication medium are available, and the Society should

decide if it will undertake a study of the matter. Closely related physical chemistry in the problems of the Society's various divisions makes this proposal a natural one. If it is conceded that the basic physical chemistry of the art is not alone inadequate to express empirical data, but is even faulty, then there would appear to be a great incentive to set up some proper means of leading, correlating, and evaluating research and engineering effort. If a program in pure research is not fit for reasonable publicity, it is fair to assume that it should be held back until it is sufficiently well organized to permit some notice to industry and to other laboratories that the work is under way. This is especially necessary to avoid duplication of effort in engineering experimentation.

The personnel in the ceramic field is of a very high order. It is inconceivable that such a personnel can not work out this problem in a manner which should give the ceramic art a largely enhanced value. Aside from serving their own ends, and those of industry, they will afford outlets for the energies of students of recent years who are not yet placed, and the students of the future, among whom let us hope there may be an Edison or a Steinmetz.

VICE-PRESIDENT, NORTH AMERICAN REFRACTORIES COMPANY
CLEVELAND, OHIO

THE ORGANIZATION AND FUNCTIONS OF THE RESEARCH COMMITTEES OF THE AMERICAN CERAMIC SOCIETY

By Robert Twells*

The Divisions of the American Ceramic Society are almost independent self-governing bodies interested in widely different phases of the ceramic industry. The research committees of these Divisions are nearly as diverse as the branches of the industry they represent. A research committee may be one man, or many; it may comprise a number of subcommittees, as in the case of the Refractories Division, or it may be a corporation with an elaborate organization such as the National Brick Manufacturers Research Foundation. This difference in organization of the research committees is a healthy sign. It shows that the research committees can develop to meet the needs of their divisions without undue restrictions.

The Division research committees are on the firing line of ceramic research. Each must recognize the research problems existing in its field, and develop ways and means to solve them. The need for research work is often apparent. When the results promise to benefit the industry as a whole, it is sometimes possible for a Division research committee to take the initiative and raise money by subscription to finance an investigation. This has been done by a number of the Divisions.

The Enamel Division has been able to secure the financing of an investigation of the causes of the blistering of enamels on cast iron.[1]

The Structural Clay Products Division, through the National Brick Manufacturers Research Foundation and in coöperation with the Common Brick Manufacturers Association, has been conducting an important study of reinforced brick masonry.[2]

The Terra Cotta Division has helped to encourage the investigations carried on through fellowships financed by the National Terra Cotta Society.

The Art Division interested the General Education Board of the Rockefeller Foundation to finance a fellowship at Ohio State University for a period of two years to study decoration and design of tableware china.[3]

The Glass Division raised a considerable sum of money which was expended at the Bureau of Standards over a period of about two and one-half years in fundamental investigations.

The Refractories Division has a very active committee working through contact committees on refractory problems of mutual interest to other organizations. The Joint Committee on Foundry Refractories with the American Foundrymen's Association, the Committee on Boiler-House Refractories of the American Society of Mechanical Engineers and Committee C-8 of the American Society for Testing Materials are examples of this type of coöperation.

The White Wares Division has helped to foster the investigations of saggers, feldspars, and the quality of chinaware, that were financed by the trade associations and carried on at the Bureau of Standards. The White Wares Division is chiefly active now through an advisory committee[4] formed to contact with the Bureau of Standards on whiteware problems. A recent article by Geller[5] covering the effect of repeated heatings

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* Chairman, Committee on Research.

[1] Emerson P. Poste, "The Blistering of Cast-Iron Enamel: Progress Report," *Bull. Amer. Ceram. Soc.*, **11** [8], 201 (1932).

[2] Edward E. Krauss and Judson Vogdes, *Jour. Amer. Ceram. Soc.*, **15** [5], 273–320 (1932).

[3] "Tableware Design Research at Ohio State University," *Bull. Amer. Ceram. Soc.*, **10** [6], 165 (1931).

[4] For report of this Committee see this issue of the *Bulletin*, p. 106.

[5] R. F. Geller, "Effect of Repeated Heatings on the Mechanical Strength of High Tension Insulator Porcelains," *Bull. Amer. Ceram. Soc.*, **12** [1], 18 (1932).

on the mechanical strength of high-tension insulator porcelains is an outgrowth of this coöperation. This list of the activities of the Division research committees is incomplete but gives an idea of the type of work they have done and can do in the future when funds can be raised to carry on the work.

The general Committee on Research has duties defined by the constitution as follows:

> To organize and encourage scientific investigations pertaining to the ceramic and related industries, especially those investigations which shall stimulate the development of our national industries and resources. It shall be empowered to coöperate with similar committees of other scientific societies and government bureaus.

Its personnel consists of a general chairman and one member, usually the chairman of the Division research committee, from each of the eight Divisions. This in effect means that the general committee has behind it all the personnel and resources of the Division committees. The general chairman is in no sense a research director for the various Division committees. He follows the work that the various committees are doing and keeps the Executive Committee of the Society informed regarding their activities. Most of the Division research committees are very active; a few whose problems are different and resources restricted are not so active. The committees are kept informed regarding the methods that have proved successful in the more active Divisions and they are encouraged to use them.

In recent years funds raised by subscription have not been available for ceramic research and it is increasingly important that existing research facilities be used to the utmost. The Committee on Research is attempting to encourage more research work along ceramic lines, and to direct the efforts of those now at work to prevent duplication. In the hundreds of colleges and universities in this country there are many teachers and students of chemistry, physics, and metallurgy who might be encouraged to take up fundamental ceramic research work in their laboratories if they were informed regarding the problems needing solution. An excellent start along this line was made a few years ago by the Research Committee of the Refractories Division, which made a list of some refractory and glass problems and circularized it among scientific workers not ordinarily reached by ceramic literature. Some fine coöperation is being obtained from Purdue University, the University of Wisconsin, and Washington and Lee University, because some men in their chemistry and physics departments have become interested in glass problems. Publicity for research problems would cost very little considering the results that might be obtained. The Committee on Research is attempting to develop for publication a list and brief description of ceramic problems upon which research study is urgently needed. Specific investigations could be assigned also to the various university ceramic departments and they would be glad to coöperate if the work were part of a definite program.

There are now some twenty-four universities and colleges which have ceramic departments actively engaged in ceramic research work. The industry can always depend upon them for splendid coöperation and valuable results. An organization, however, such as the Committee on Research, is needed to correlate their activities and prevent duplication of effort. When someone gives a preliminary report of some interesting work, there is a natural tendency for several groups to jump in and, each unknown to the other, follow up the same line of research. This practice is not only wasteful but it encourages secrecy, and discourages the publication of preliminary reports. The remedy for this situation is publicity, as far as possible, for the research programs of the various schools and government bureaus. The *Bulletin of the American Ceramic Society* is an ideal "board" on which to post the research schedules under way. For this purpose the Committee on Research and the Editor of the *Bulletin* are coöperating to set

up the necessary space. A letter to the various ceramic schools brought out favorable comment and offers of coöperation.[6] Several submitted news items of the research studies they have under way, and these are in process of publication. It is believed that this work is important and should be continued. Probably the best means to accomplish it would be through questionnaires sent out several times during the school year.

Several of the Division research committees have been successful in organizing or acting as advisory committees to government bureaus. This work should be extended also to include the ceramic schools and trade associations. The Committee on Research, including the Division committees, has a valuable resource in its personnel, consisting as it does of able men from every phase of the ceramic industry. Each one is well aware of the needs in his own field, and can provide viewpoints from industrial as well as technical angles. These men are not only willing to suggest research studies but are willing to help in the work by attending conferences, providing plant samples, and conducting factory tests. To any one conducting ceramic research the Committee on Research of the American Ceramic Society should be very valuable. To government bureaus, ceramic schools, and ceramic trade associations its services in an advisory capacity should be almost indispensable. To these organizations it offers its full coöperation and asks nothing in return except the knowledge that it has helped advance the progress of the ceramic industries.

CHAMPION SPARK PLUG COMPANY
CERAMIC DIVISION
DETROIT, MICHIGAN

[6] Replies from the ceramic schools concerning their research work are published in this issue of the *Bulletin*, p. 111.

ACTIVITIES OF THE SOCIETY

OUR THIRTY-FIFTH ANNUAL MEETING

Our 1933 Meeting was a success. Six hundred and fifty-eight persons were registered. There were fifty students, sixty-one ladies, and twenty-three guests, and, as usual, a number who did not register.

The technical programs were of more value and were conducted more successfully than for any previous year on record.

The social and entertainment features, including those for the ladies were of a high order of excellence, for which there was unanimous praise from the attending guests.

The plans made and the service rendered by the Local Committee were exceptional and most praiseworthy. Alexander Silverman, Robert Ferguson, and Mrs. Stuart Phelps, as well as the entire list of workers gave freely of their energy and time to make events go smoothly and happily.

The reports and papers, as they appear in the monthly publications of the Society through the year will reveal the excellence of this instructive Annual Meeting.

HISTORICAL DATA ON THE AMERICAN CERAMIC SOCIETY

The history of the American Ceramic Society from the day of its conception in 1898 and its founding and incorporation in 1889 up to 1923, inclusive, has been given in a detailed story in the *Journal*, Volume 6, No. 1, 1923. Please note the following correction for the story in Volume 6 (page 35), as well as in preceding lists in the annual *Transactions* published by the Society up to 1918: In each of these lists the meeting held in Rochester in 1909 with Ross C. Purdy as President Elect and Arthur S. Watts as Vice-President Elect was inadvertently omitted. Hence this is the first corrected list published since 1908.

Year	Meeting Place	President Elect	Vice-President Elect
1899	Columbus, Ohio	H. A. Wheeler (general)	Ernest Mayer
1900	Detroit, Mich.	Karl Langenbeck (general)	Charles F. Binns
1901	Old Point Comfort, Va.	Charles F. Binns (art)	Ernest Mayer
1902	Cleveland, Ohio	Ernest Mayer (whiteware)	Francis W. Walker, Sr.
1903	Boston, Mass.	E. C. Stover (whiteware)	Heinrich Ries
1904	Cincinnati, Ohio	F. W. Walker, Sr. (whiteware)	A. V. Bleininger
1905	Birmingham, Ala.	W. D. Gates (terra cotta)	Ellis Lovejoy
1906	Philadelphia, Pa.	W. D. Richardson (structural clay)	Samuel Geijsbeek
1907	St. Louis, Mo.	Stanley G. Burt (art)	Ross C. Purdy
1908	Columbus, Ohio	A. V. Bleininger (whiteware)	Charles Weelans
1909	Rochester, N. Y.	Ross C. Purdy (general)	Arthur S. Watts
1910	Pittsburgh, Pa.	Heinrich Ries (general)	Richard R. Hice
1911	Trenton, N. J.	Charles Weelans (whiteware)	Lawrence E. Barringer
1912	Chicago, Ill.	Arthur S. Watts (general)	Cullen W. Parmelee
1913	Washington, D. C.	Ellis Lovejoy (structural clay)	Adolph F. Hottinger
1914	Wheeling, W. Va.	C. W. Parmelee (general)	Dwight T. Farnham
1915	Detroit, Mich.	Richard R. Hice (structural clay)	Ray T. Stull
1916	Cleveland, Ohio	L. E. Barringer (whiteware)	Forrest K. Pence
1917	New York, N. Y.	George H. Brown (general)	C. E. Jackson
1918	Indianapolis, Ind.	H. F. Staley (enamel)	A. F. Greaves-Walker
1919	Pittsburgh, Pa.	Ray T. Stull (structural clay)	Roy H. Minton
1920	Philadelphia, Pa.	Roy H. Minton (whiteware)	Earl T. Montgomery
1921	Columbus, Ohio	Forrest K. Pence (whiteware)	Fred B. Ortman
1922	St. Louis, Mo.	Frank H. Riddle (whiteware)	E. Ward Tillotson
1923	Pittsburgh, Pa.	A. F. Greaves-Walker (refractories)	R. D. Landrum
1924	Atlantic City, N. J.	R. D. Landrum (enamel)	R. M. Howe and August Staudt
1925	Columbus, Ohio	E. Ward Tillotson (glass)	Frederick H. Rhead
1926	Atlanta, Ga.	R. L. Clare (terra cotta)	B. Mifflin Hood

Year	Meeting Place	President Elect	Vice-President Elect
1927	Detroit, Mich.	B. Mifflin Hood (structural clay)	M. C. Booze
1928	Atlantic City, N. J.	M. C. Booze (refractories)	R. R. Danielson
1929	Chicago, Ill.	George A. Bole (general)	Fred A. Harvey
1930	Toronto, Canada	Edward Orton, Jr. (general)	Paul E. Cox
1931	Cleveland, Ohio	E. V. Eskesen (terra cotta)	Alexander Silverman
1932	Washington, D. C.	Emerson P. Poste (enamel)	W. Keith McAfee
1933	Pittsburgh, Pa.	John C. Hostetter (glass)	Louis J. Trostel

REPORT OF PUBLICATIONS COMMITTEE, AMERICAN CERAMIC SOCIETY, 1932–1933*

The Publications Committee for 1932–1933 presents the following report of its activities.

Milton F. Beecher, Norton Company, was appointed to serve in place of A. E. R. Westman who was forced by press of other business to resign.

A joint meeting of the Publications Committee and a special committee consisting of V. V. Kelsey, J. M. McKinley, and Edward Schramm, was called at Corning, N. Y., on May 16, 1932, to review the work of the Special Committee having to do with proposals for increase in the revenue by means of a more attractive cover design for the *Journal* and the separate publication of the *Bulletin*. The meeting was attended by Messrs. Purdy, Schramm, Navias, and Littleton.

It was recommended at this meeting that a complete estimate of the costs of the proposed change together with the expected increase in revenue be obtained by Secretary Purdy and submitted to the Publications Committee.

Several cover designs were submitted by Secretary Purdy for discussion. Dr. Navias submitted a design made by Mr. Reagles of the General Electric Company. This matter was referred to the Secretary for additional design work.

The Publications Committee approved the change in print, type, and spacing in the *Journal*.

There has been no further report from the Secretary on the costs of a separate publication of the *Bulletin*.

In addition to the cover designs submitted by Secretary Purdy and Dr. Navias, a later design submitted by Frederick Carder was approved and adopted. This design appeared first on the January, 1933, issue.

A change in paper leading to a slight saving was approved. This change appeared in the January, 1933, issue.

The style sheet to authors and technical nomenclature was reviewed, modified, and adopted.[1]

The 1933 printing contract was renewed with the Mack Printing Company on the basis of their past satisfactory service, with the understanding that they review and pass on to us any possible saving in printing costs.

Members from the Society were appointed as reviewers of abstracts. As soon as a satisfactory operating test has been secured proving the desirability of continuing the functions of these reviewers the mechanism of their appointment will be properly formulated.

The desirability of the continuation of the Division Editorial Committees having been demonstrated, together with the need of a uniform and specific statement of their functions and operations, a set of by-laws covering these details was published.[1] The adoption of these or equivalent by-laws is urged.

The Committee desires to go on record with its sincere and hearty commendation of the Editor and his staff for their work. The quantity and quality of material published has been kept up to standard at a much decreased cost. The work has been accomplished at a figure below the budget allowance. This has only been possible through the foresighted planning and zealous efforts of our Editor and of his staff. This work should be recognized and appreciated.

Respectfully submitted,

Chairman, J. T. LITTLETON M. F. BEECHER
LOUIS NAVIAS L. J. TROSTEL

* Submitted January 11, 1933.

[1] See *Bull. Amer. Ceram. Soc.*, **12** [1], 26–32 (1933).

REPORT OF COMMITTEE ON GEOLOGICAL SURVEYS FOR 1932*

This Committee, as part of its work, each year is undertaking to collect and tabulate information on the work of the various state geological surveys or bureaus, and on current reports issued by them or in process of preparation on ceramic raw materials.

In 1932, thirty-six states answered the questionnaire sent out by the Committee. Of these, twenty-one reported that some work on ceramic materials was under way. Nearly all the states reported that lack of funds prevented carrying on the work as desired and they had curtailed or would curtail or completely stop future work.

Nearly all of the work at present has to do with the geology, mode of occurrence, or economic possibilities of undeveloped ceramic resources. Very little fundamental research has been carried on and there is but little duplication as the work in the different states relates almost wholly to deposits within the state and to local conditions affecting the particular areas. It may also be noted that there is no apparent duplication of research with research activities listed and abstracted in U. S. B. M. I. C. 6637, "Research Activities in the Mineral Industries of the United States."

The reports from the different states in which work was under way in 1932 are abstracted as follows:

Alabama In December, 1931, the School of Chemistry, Metallurgy, and Ceramics of the University of Alabama, in collaboration with the Alabama Industrial Development Board, collected 1275 clay samples from different parts of the state. These were given a preliminary test. Further investigation was prevented for lack of funds. A preliminary report was prepared by T. N. McVay and some copies of this made by the Alabama Industrial Development Board.

Arkansas No systematic work on account of lack of funds. Ceramic tests have been made on some samples from promising deposits. Bentonite deposits south of Little Rock in Saline County have been carefully examined. Funds for 1933 are uncertain.

California Walter W. Bradley, *State Mineralogist*, Division of Mines. A general nonmetallic survey in Ventura County and the San Jacinto quadrangle in Riverside County, published in the quarterly chapters dated January, July, and October, 1932. A survey of the limestone resources of California is under way and will be continued during 1933. No specific ceramic survey planned for 1933.

Georgia Richard W. Smith, *Assistant State Geologist*, has been engaged since the fall of 1931 on a survey and report on the mica, feldspar, and primary kaolin deposits of Georgia. Cyanite deposits have also been visited and will be described in an appendix to the report. The field work for this report will be continued during 1933 and it is expected that a bulletin will be published in 1934 if funds are available. A paper on "The Shales and Brick Clays of Georgia," by Mr. Smith, was presented at the 1931 Meeting of the Society (see *Jour. Amer. Ceram. Soc.*, **16** [1], 36–44 (1933).

Idaho J. W. Finch, *Secretary of the Board of Control*, Idaho Bureau of Mines and Geology, Pamphlet No. 38, Dec., 1932. A number of reports on the clays of Latah County, Idaho, have been issued prior to 1932. Mapping the topography and geology of Latah County and study of its clays and other mineral resources, are now nearly completed. Reports for 1932: A. L. Anderson, *Econ. Geol.*, "Genesis of the Mica Pegmatites of Latah County, Idaho"; E. L. Tullis, *Pit & Quarry*, "The Nonmetallic Mineral Resources of Idaho"; F. B. Laney and E. L. Tullis, *Northwest Sci.*, "The Clays of Idaho and Eastern Washington," as well as numerous other mineral and geological publications.

Indiana A report has been completed covering the experimental work on clays of Indiana by the Division of Geology of the Department of Conservation. Publication of the report is planned for 1933.

Iowa Examination and selective sampling of known existing clay deposits were conducted by C. S. Gwynne of Iowa State College with the object of locating suitable light firing and bright red firing clays for structural clay products. About $1000 were available in 1932 and as much is anticipated for 1933. When field and laboratory work are completed a report will be published by the Iowa Geological Survey.

Maryland At the University of Maryland, F. H. Kellogg is conducting research on clays with the object of determining the effect of mineralogical composition on plasticity and permeability. Tests are made first on monomineralic clays, and sands, artificially concentrated.

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* Similar data for 1930 were published in *Bull. Amer. Ceram. Soc.*, **10** [2], 35; [5], 137 (1931).

Massachusetts The Massachusetts Industrial Commission, Boston, has issued a report on the mineral resources of the state which contains references to the clay resources.

Missouri A microscopic study of the clays of the state is being carried on by the Bureau of Geology and Mines. This work so far is confined to high-grade fire clays of the north-central Ozark region. Examinations have been made of thin sections of diaspore, burley, and flint clays. This work is being coördinated with a study of beneficiation of these clays previously carried out and samples of the results of beneficiation are included in the microscopic study. Reasons for the peculiar firing behavior of the clays are being sought.

It is hoped that one full time geologist can be assigned to field work during the 1933 field season.

Nevada J. A. Fulton, *Director*, Nevada Bureau of Mines, Reno. A bulletin by J. A. Fulton and A. M. Smith, "Nonmetallic Minerals of Nevada" (10 cents) has been published; another is in press, "Metal and Nonmetal Occurrence in Nevada" (50 cents). The latter is similar to U. S. Geol. Surv. *Bull.*, No. 507. No other nonmetallic work is planned.

New Mexico The State Bureau of Mines and Mineral Resources of the New Mexico School of Mines, Socorro, are preparing a report on the nonmetallic mineral resources of the state. This will include a section on clays. It will probably be issued in the spring of 1933.

North Carolina In June, 1932, the Engineering Experiment Station of the University of North Carolina published Mimeograph No. 3, "Improving the Working Qualities and Increasing the Dry Strength of North Carolina Shales by the Addition of Common Acids to Pug Water," by W. C. Bangs and A. F. Greaves-Walker. A report on the "Occurrence, Properties, and Uses of North Carolina Clays and Shales," by A. F. Greaves-Walker, N. H. Stolte, and W. L. Fabianic was completed. Work on this has extended over seven years. It will be published as a bulletin of about 100 pages through the Engineering Experiment Station (also published in *Jour. Amer. Ceram. Soc.*, **16** [1], 6–11 (1933)).

An investigation on the "Physical Properties Produced in White Bodies by Substituting Cornwall Stone Made from North Carolina Feldspar for English Stone," is now under way by the Department of Ceramics of the University of North Carolina under the supervision of A. L. Greaves-Walker.

North Dakota College of Engineering, University of North Dakota, has made field surveys to discover ceramic materials and collect samples. Tests have been made and are now being conducted on these materials and efforts are being made to find uses for them. One problem studied is the ceramic use of North Dakota bentonite as an engobe to replace the glaze on pottery. Work is being done on the development of a lightweight building material from North Dakota materials. A report on the results of these investigations is being prepared which may be published during 1933. A fund of $1200 is expected for 1933 to carry on the work.

Ohio The Geological Survey of Ohio has a report in progress on the red-firing clays of Ohio, including shales, alluviums, and glacial drift. Funds are lacking for publication. During 1932, *Bull.* No. 36 on the "Lawrence Clay of Lawrence County," by Wilbur Stout, Myril C. Shaw, G. A. Bole, and Downs Schaaf was issued in cooperation with the Ohio State University Eng. Expt. Station and the Ironton Chamber of Commerce.

Pennsylvania A progress report is now in press on the clays and shales of southwestern Pennsylvania based on the work of Henry Leighton of the University of Pittsburgh for the State Topographic and Geologic Survey. Samples collected were tested at Pennsylvania State College. The budget for 1933–1935 requests $5000 for continuation of the work.

The work of the Greater Pennsylvania Council in connection with the Mellon Institute on clays, especially the beneficiation of the fire clays, was discontinued due to lack of funds on account of the withdrawal of appropriations by the state for the Council.

Tennessee The Geological Survey had one man for two months beginning a detailed survey of clay and shale resources of the state. Two to three years will be required to complete the work if funds are available. Funds are available to July, 1933.

Texas The Bureau of Industrial Chemistry of the University of Texas is testing ceramic materials submitted to it from deposits within the state. It is hoped to build up a knowledge of the clay resources in this way.

About $1500 per year is spent on this work. There has been a decrease in demand for standard ceramic tests and an increase in demand for tests of special properties as those of bentonite, etc. A bulletin covering the results to May, 1931, has been published. This includes a report on the kaolin deposits north of Uvalde.

Virginia The Virginia State Geological Survey *Bull.* No. 33, on "Pegmatite Deposits of Virginia," recently published, treats of the feldspar deposits of the state. A report is being written on the formations west of the Blue Ridge, but this will not be available for publication for more than a year. "Geologic Map of the Appalachian Valley in Virginia," which includes all of the state west of the Blue Ridge will be published in 1933. This map will be useful to ceramists in showing the distribution of the different shale formations.

The Ceramic Engineering Department, Virginia Polytechnic Institute, has been working on the commercial possibilities of the use of tannic acid additions to the clays and shales of Virginia in order to improve their properties. A report will be published on this subject in 1933.

Experimental work is being done on Virginia cyanite. Work has been carried on the past three years on ceramic raw materials in Virginia but no report has been published.

Washington University of Washington, Seattle, in coöperation with Northwest Experiment Station, U. S. Bureau of Mines. Past publications have covered the clays, the ochers and mineral pigments, feldspar, the fire clays, methods of purification and dewatering kaolins, etc. Ready for publication: "The Iron Oxide Mineral Pigments of the United States," "A Simple Dispersion Test for Clays," "Purification of Kaolins by Air Flotation," "The Dewatering of Kaolins by Spray Evaporation," "The Kaolins and Whiteware Materials of the Pacific Northwest." In preparation: "Chalk and Whiting of the United States," "Quartz Sands of the Pacific Northwest."

West Virginia West Virginia University has begun a study of fire clays of the state. Forty samples have been collected and are being tested. Activities, however, will not be continued on this during 1933.

Respectfully submitted,
Committee on Geological Surveys,

Chairman, W. M. WEIGEL
J. E. LAMAR
JOHN W. WHITTEMORE
HEWITT WILSON

STANDARDS COMMITTEE REPORT*

To the American Ceramic Society:

This Committee during the past year has received no report of any new standard, tentative standard, or change approved by any Division, and hence has no new material to report.

On September 24, 1932, a communication to every Division chairman and Division standards committee, urged a careful study of the present standards material for the purpose of bringing to the attention of their Division new material for action at the 1933 Meeting. On December 22, 1932, another communication to each Division chairman and standards committee, again urged action, and a list of items and references of special interest to each Division was attached.

The Enamel Division representative reports (1) a proposed change in Methods of Chemical Analysis for Ceramic Products High in Titanium, Zirconium, and Iron, and (2) a proposed change in A-18-Thermal Expansion Apparatus.

The Glass Division representative reports that industrial conditions and reduced federal budgets have made it impossible to conduct necessary research on which to base glass standards. Our suggestion that the various types of glass be defined was accepted. The need of standard nomenclature, physical tests, and methods of analysis was recognized, and the purpose indicated to coöperate with the German and English societies along these lines.

The Materials and Equipment Division has promised to coöperate in developing standards on ceramic materials.

* Submitted January 25, 1933.

The Refractories Division representative has reported 13 changes in definitions and 70 changes in wording of tests to bring refractories material up-to-date, and to correspond with A. S. T. M. Recommendation for the adoption, as tentative, of the Panel Spalling Test developed at Mellon Institute.

The Structural Clay Products Division representative has reported proposed changes in the standard specifications and tests of Common Brick and Sewerpipe. Also, a test procedure and apparatus for Extruding Test Bars is proposed.

The White Wares Division has undertaken to promote standard tests for China, Porcelain, and Earthenware Tableware. Test methods for use in controlling casting slips are also proposed. The study of nomenclature of whitewares is also still under consideration.

In addition to the promotion of activity in the various Divisions, the Standards Committee has been active in the following matters:

(*a*) Development of Specifications on Testing Sieves, in coöperation with A. S. T. M. and A. S. A.

(*b*) Promotion of a more accurate testing sieve in the smaller size openings.

(*c*) Coöperation with the Inter-Society Color Council. The Society not being affiliated with this Council, no active participation is possible.

(*d*) Collection of information on testing apparatus for consideration of various Division standards committees and of the general Standards Committee.

The greatest need of the Standards Committee is to have the Divisional officers and committees understand the procedure in creating standards and not depend on the general Standards Committee for the development of standards. The general Standards Committee has no authority to create standards for any Division, and can only consider such standards as have been approved by some Division.

Respectfully submitted,

ARTHUR S. WATTS, *Chairman*

Standards Committee, American Ceramic Society

PROPOSED CONSTITUTION AND BY-LAW AMENDMENTS AMERICAN CERAMIC SOCIETY

The following proposed amendments were presented at the Thirty-Fifth Annual Meeting, American Ceramic Society, and are now being presented for the consideration of the active members.

Article II. Section (3)

Change to read as follows:

Honorary Members shall be nominated by at least ten Active Members and unanimously approved by the Board of Trustees. Such nominations shall be placed before the Fellows at their annual meeting and must receive the affirmative vote of at least 90% of those present and voting.

Article II. Section (5)

Change to read as follows:

(5) Fellows shall compose a group of Active Members upon whom this title is conferred in recognition of outstanding contributions to Ceramic Arts and Science.

Eligibility for the grade of Fellow requires that Active Members shall be at least thirty years of age, shall have been enrolled as Active Members not less than five years, and shall have won distinct recognition in the Society by (*a*) sustained interest in and devotion to the objects of the Society and high professional ideals or (*b*) broad and productive scholarship in Ceramic Science or (*c*) conspicuous achievement in some branch of the Ceramic Arts.

The methods to be used in judging the qualifications and determining the eligibility of nominees shall be devised and administered by the Fellows.

Article II. Section (6)

Change to read as follows:

(6) Nominations for promotion to the grade of Fellow must be made by seven or more Active Members of whom at least four must belong to the Division with which the nominee is affiliated, the application to be made by the sponsors upon a form approved by the Fellows and to comprise a full record of the nominee's educational, professional, and other qualifications.

All applications for promotion to the Fellowship must be transmitted by the Chairman of the nominee's Division to the Dean of Fellows who shall in turn submit the proposal to the Fellowship Board which shall act upon all such applications under the rules of the Fellows.

The Fellowship Board shall consist of nine Fellows appointed by the Dean of Fellows and shall represent all Divisions of the Society. An affirmative vote of seven shall be required for acceptance of the nominee for the grade of Fellow.

Notifications of the acceptance shall be transmitted by the Fellowship Board to the Dean of Fellows who shall forward such nominations to the Board of Trustees for ratification, after which the nominee is duly elected and shall be so notified by the Dean of Fellows and publicly inducted into the Fellowship.

Induction of Fellows shall take place at the next Annual Meeting of the Society following election to Fellowship unless circumstances necessitate some other arrangement.

Nominations not ratified by the Board of Trustees shall be returned to the Dean of Fellows and by him to the Fellowship Board with the reasons for disapproval.

Nominations not accepted by the Fellowship Board shall be laid on the table for one year at the expiration of which time such applications may be taken up by the Fellowship Board for review and reconsideration or another application for the same nominee filed by the original or by another group of sponsors.

Persons elected to Fellowship shall be presented with a suitable certificate of election and may use the title Fellow, American Ceramic Society or the abbreviation F.A.Cer.S.

Article II. Section (14)

In the fourth line change the reference to Article VII, Section 4 to Article VII, Section 3.

Article VII. Section (2)

Amend to read as follows:

(2) The Board of Trustees, Divisions, Committees, or any constitutionally organized group within the Society may refer to the Fellows any matters upon which the opinion of the Fellows, as a group, is desired, such as matters of general policy and professional ethics.

Article VII. Section (3)

Delete.

Article VII. Section (4)

Amend to read as follows:

(3) In the event of the filing of written charges against any member of the Society, as provided in Article II, Section 14, the matter shall be referred to a special committee of eight Fellows, one from each Division, appointed by the President of the Society. The Dean of Fellows shall serve ex-officio as chairman of this special committee.

The member against whom charges are directed shall be notified of such charges in detail and of the date for their consideration to provide full opportunity for appearance before the committee in person or by counsel or for the filing of a written defense.

The special committee of Fellows shall report its findings and recommendations to the Board of Trustees which may accept or reject the recommendations, the decision of the Board to be final.

Article VII. Section (5)

Delete.

Article VII. Section (6)

Delete.

Article VII. Section (7)

Change the designation of this section from (7) to (4) and to read as follows:

The affairs of the Fellows shall be managed by a Dean, Associate Dean, and Secretary-Treasurer with such other officers as may be deemed necessary.

Ninety days prior to the Annual Meeting, the Dean shall appoint two Nominating Committees, each to be composed of five members. Each Committee shall select a candidate for Dean, a candidate for Associate Dean, and a candidate for Secretary-Treasurer by majority vote, reporting the names so selected to the Secretary of Fellows not less than thirty days prior to the Annual Meeting.

The Secretary shall send out to all Fellows printed ballots bearing the names of the nominees of the two Committees in alphabetical order at least twenty days prior to the Annual Meeting. The ballots when voted and returned to the Secretary of Fellows shall be turned over at the Annual Meeting to a Committee of two scrutineers, to be designated by the Dean, which shall promptly determine and report the results of the election of the officers.

Article VII. Section (8)

Amend to read as follows:

(5) There shall be held one or more meetings of the Fellows at each Annual Meeting of the Society, at such time and place as may be agreed upon, and the Secretary of the Society shall make provision for such meetings and place them upon the printed program of the Annual Meeting of the Society.

The Fellows will provide such programs for the meetings as they deem appropriate or desirable.

The Fellows shall hold such other meetings as they deem necessary or desirable.

Article VII. Section (9)

Change the designation of this section from (9) to (6).

Article VII. Section (10)

Change to read as follows:

(7) Fellowship dues in excess of regular dues for Active Members shall be set aside by the Board of Trustees as a special fund to be used only for purposes specified and authorized by the Fellows through the Dean and Secretary-Treasurer of the Fellows.

Changes of Rules with Respect to Publications

Article VIII

After present paragraph (2) the following paragraph is to be inserted:

(3) Each Division shall have an Editorial Committee of three, this Committee being chosen in any manner desired by the Division. The members of divisional Editorial Committees will serve for three years but will be so designated at the outset that one member retires at each Annual Meeting, so that one new member is elected annually.

The senior member of the Committee shall act as Chairman and the duties of the Committee shall be as outlined in Article XI paragraph (4).

Renumber paragraphs (3) (4) to paragraphs (4) (5).

Article XI

Change paragraph (3) by deleting the second sentence.

Change paragraph (4) to read as follows:

All papers, discussions, and other writings which have been presented before the Society, its Divisions, or Sections, and all committee reports shall become the property of the Society. Their publication or other disposition shall be in the hands of the Committee on Publications.

The dealings of all authors with the Society shall be through the Editor's office.

When a paper submitted for publication is received in the Editor's office it shall be dated, acknowledged, and edited for *Journal* uniformity and practice. The Editor's recommendations for or against acceptance and for such changes as he deems desirable (if any) shall be attached and considered a part of his editing.

The original paper with the Editor's recommendations and editing shall be sent to the divisional Editorial Committee with whose major interest the paper deals. This

Committee shall review the paper, together with the recommendations and proposed changes submitted by the Editor and shall decide

(*a*) That the paper should not be accepted for publication, or
(*b*) That it should be accepted for publication as it stands or after having been changed and corrected in accordance with the recommendations.
(*c*) If the paper is accepted for publication, where it should be published.

The paper shall then be returned to the Editor, who, if he agrees with the divisional Editorial Committee, shall act accordingly, *i.e.*, (*a*) return the paper to the author with the information that it is not suitable for publication by the American Ceramic Society or (*b*) inform the author that it is suitable for publication as it stands, or will be with the changes proposed.

When the author has made the corrections proposed and returned the paper to the Editor, it is ready for publication at the Editor's discretion.

If the author does not elect to make all changes in the paper as recommended, he may request the Editor to refer the whole matter to the Committee on Publications whose decision shall be final. If he wishes to change or amend the paper in some manner other than as recommended, the whole paper shall then be handled as though it were a new contribution entirely.

If the Editor shall not accept the recommendations of the divisional Editorial Committee, he shall at once clearly define his objections to its Chairman. The Chairman shall review these objections with his Committee and shall promptly report to the Editor that the Committee "does" or "does not" acquiesce.

If the Committee does not acquiesce, the Editor shall submit the original paper, and all letters and other materials pertaining thereto, to the Committee on Publications for final decision through the divisional Editorial Committe.

The acceptance of an author's paper, though modified by the Society's agencies as above described. shall not imply the acceptance of responsibility for opinions and conclusions. The author is alone responsible for these opinions and conclusions.

Any papers, discussions, or writings not considered suitable for use in the publications of the Society by the Editorial Committees or Committee on Publications must be returned to the authors for free use elsewhere and, upon request of authors, decision in this matter must be rendered within sixty days.

Executive Committee

For recommended constitutional amendments relating to the Executive Committee see *Bull. Amer. Ceram. Soc.*, **11** [3], 74 (1932).

Committee on Management

For recommended constitutional amendments relating to the Committee on Management see reference above.

Proposed Constitution and By-Law Amendments for Further Consideration

To carry out the plan sponsored by the Board of Trustees and approved by the Fellows and the Committee on Rules with respect to the vice-presidency, the following constitutional changes are proposed for consideration, but not for vote this year.

Article IV. Officers

Change paragraph (4) to read as follows:

The vice-president shall preside at all meetings in the absence of the president. If the place of president should become vacant, the vice-president shall be vested with all powers and required to perform all the duties of that office for the remainder of the unexpired term.

The vice-president shall become president of the Society for the year immediately following his term as vice-president.

If the office of vice-president should become vacant, the Board of Trustees shall appoint a vice-president *pro tem* until a special election to fill the office has been held.

Article V. Nominations and Elections

Change paragraph (1) to read as follows:

A Nominating Committee shall be selected at each Annual Meeting, this Committee to consist of one member from each Division of the Society. The divisional members of

the Nominating Committee shall be elected at the final session by each Division during the Annual Meeting. The names of these divisional representatives upon the Nominating Committee shall be regularly reported to the Secretary by the Chairman or acting Chairman of each Division.

The Nominating Committee shall be notified of its membership by the Secretary and shall at once appoint its own chairman and proceed to the nomination of officers for the ensuing year.

Change paragraph (2) to read as follows:

Nominations for vice-president and treasurer.

The Nominating Committee shall by a majority letter vote select two nominees for each office of vice-president and treasurer.

Change paragraph (3) to read as follows:

(Election.) The names of nominees for vice-president and treasurer, their assent having been obtained before nomination, shall be placed upon a printed ballot in alphabetical order and such ballots mailed not less than twenty days before the Annual Meeting to each voting member not in arrears at the time.

The ballot shall be enclosed in an envelope upon which there shall be no mark of identification other than the word "ballot." The envelope shall be enclosed in another envelope for mailing, addressed to the Secretary, upon the back of which the voter shall place his name.

The envelopes and ballots shall be opened in the presence of three scrutineers appointed by the President, these scrutineers to report the result of the election at the Annual Meeting.

A plurality of affirmative votes cast shall elect.

ANNUAL REPORT OF THE GLASS DIVISION, AMERICAN CERAMIC SOCIETY, FOR 1932–1933

The usual Summer and Annual Meetings were held by the Glass Division. The Summer Meeting was attended by thirty-five members who spent several days at the Woodmont Rod and Gun Club near Hancock, Maryland. The success of this meeting has been indicated in the press and no further comment is needed here.

The regular meeting of the Division which was held with the other Divisions of the Society at the Wm. Penn Hotel in Pittsburgh, Pa., during the week of February 12 was marked by an excellent variety of papers, and was well attended. Over one hundred persons actually interested in the field of glass technology were present. The Division is indebted to the Chairman of the Program and Papers Committee, H. H. Blau, for having arranged this meeting which has been declared by several to have been the best they ever attended.

The Division is happy indeed to find that one of its members, J. C. Hostetter, has been made president of the Society.

Along the line of new business F. C. Flint proposed at the Pittsburgh Meeting that the Division establish a Translation Committee whose duty it would be to arrange for the translation of foreign articles on the subject of glass technology. The idea met with favorable comment and a motion was passed to proceed with the matter. The Chairman of the Division is to appoint a Chairman for a Translation Committee who will proceed with the work. The new project is to be financed by personal and company subscriptions which it is estimated will amount to about fifty cents per article. J. T. Littleton suggested that the number of translations be not limited and that all members be urged to offer suggestions to the Committee after it has been appointed.

The Glastechnische Tabellen Committee, organized some time ago to assist in the distribution and preparation of a bulletin on the new publication by Eitel, Pirani, and Scheel, has started to work. D. E. Sharp is Chairman of this Committee and will be assisted by S. R. Scholes and K. Lark-Horovitz. The main idea of this work is to provide a descriptive bulletin with an ample glossary which will enable English speaking technologists to use this very valuable German book with more ease.

At the end of the year 1931–1932 the permanent secretaryship established a year before by the Glass Division was discontinued. The remainder of the fund raised

to defray the expenses of this office has been divided up and returned to the original donors.

At a meeting of the Executive Committee last summer a number of questions were considered. In regard to the proposed International Glass Standards it was decided that no real reason existed for the establishment of such figures. Further action on the subject was dropped.

The idea of a future Management Division for the Ceramic Society was looked upon with favor more particularly because it would provide a place for papers of this type. Due to the depressed condition of business it was decided to discontinue for the time being the glass research work started by the Division some time ago. There is still a balance on hand in this fund and at a later date it may be possible to get things under way again.

Arrangements for a joint meeting with the American Chemical Society in Washington during the week of March 26, 1933, have been completed by F. C. Flint. A meeting with H. E. Howe of the Chemical Society took place at the Summer Meeting when arrangements as to type of papers to be presented and other details were arranged. It is thought that joint meetings of this type will assist in drawing together a wider range of people interested in the subject of glass technology and pave the way for a better general conception of the problems involved in this field.

An interesting report was made by the Illuminating Glassware Committee at the Pittsburgh Meeting.

The Nominating Committee made the following recommendations for officers during the coming year:

Chairman, H. H. Blau
Vice-Chairman, James Bailey
Secretary, S. R. Scholes

This report was accepted and the nominees unanimously elected.
No reports were made by the other ten committees of the Division.

JACK H. WAGGONER, *Secretary*

MINUTES OF THE REFRACTORIES DIVISION, AMERICAN CERAMIC SOCIETY

The business session of the Refractories Division was held on February 15, 1933, following the morning technical session. The plan had been agreed upon by letter ballot.

Reports of the Division committees were given. S. M. Phelps, Chairman, suggested the continuation of the symposium on the alumina-silica system for the next Meeting.

L. J. Trostel, reporting for the Editorial Committee and as a member of the general Publications Committee, reviewed the change in by-laws governing publications.

S. M. Swain reported for the Committee on Standards and submitted new standard methods for spalling and pyrometric cone equivalent. F. A. Harvey made a motion (which was carried) to have these methods published in the *Bulletin* of the Society, and to be voted on by letter ballot.

Mr. Swain, at the request of A. S. Watts, Chairman of the Standards Committee of the American Ceramic Society, made a motion that the Refractories Division approve all standards adopted by Committee C-8, A. S. T. M., and automatically adopt them as standards for the Society. This motion was tabled.

The subject of the annual Division dinner was brought up and it was thought possible that by selling tickets at every session of the Division during the Meeting, a successful Division dinner could be held. This matter was left to the Division Executive Committee to handle.

The report of the Nominating Committee was submitted, and election held by proper ballot. The following officers were elected for the year 1933–1934:

Chairman: R. A. Heindl
Vice-Chairman: H. E. White
Secretary-Treasurer: R. B. Sosman
Nominating Committee { A. E. R. Westman, S. M. Phelps

Respectfully submitted,
H. E. WHITE, *Chairman*

February 17, 1933.

REPORT OF REPRESENTATIVE OF REFRACTORIES DIVISION COMMITTEE ON STANDARDS, SUBCOMMITTEE ON TESTS

The standard and tentative standard tests of the American Ceramic Society used in connection with refractories and refractory materials have been reviewed critically and the following recommendations have been made to the Committee on Standards:

(1) That all standards of this Society involving refractories or refractory materials which were the same as corresponding standards of the American Society for Testing Materials in the 1928 report of the Committee on Standards be revised to conform to the present A. S. T. M. standards.

(2) That the Absorption Test which is a part of the A. S. T. M. Standard Methods of Testing Brick (Compression, Flexure, Absorption) A. S. T. M. Designation: C-67–31 be adopted as a Tentative Standard of this Society.

(3) That the A. S. T. M. Tentative Methods of Test for Particle Size of Ground Refractory Materials, A. S. T. M. Designation: C-92–32-T be adopted as a Tentative Standard of this Society.

(4) That the Standard Method of Testing for Pyrometric Cone Equivalent be changed to conform to the A. S. T. M. Tentative Revision of Standard Method of Test for Softening Point of Fireclay Brick (C-24–31) with the following exceptions: (*a*) that the term "softening point" be replaced by the term "pyrometric cone equivalent" throughout the test; (*b*) that the cones be embedded in the plaque to a depth of approximately 3 mm. ($^1/_8$ in.); (*c*) that the arrangement of the test cones be such that all the standard Orton cones from cone 20 to the highest desired may be mounted in one plaque with the test cones; and (*d*) that a new illustration be used to show this arrangement and to show a cone deformed under uniform heat conditions.

WHITE WARES DIVISION ADVISORY COMMITTEE TO THE BUREAU OF STANDARDS

By Louis Navias*

I. Organization

At the Cleveland Meeting in February, 1931, Karl Langenbeck called a meeting at which fourteen men were present to consider the establishment of a White Wares Advisory Committee. Those present were L. E. Barringer, A. V. Bleininger, G. H. Brown, E. H. Fritz, R. F. Geller, Chas. J. Kirk, T. A. Klinefelter, H. M. Kraner, K. Langenbeck, E. T. Montgomery, Louis Navias, F. H. Riddle, E. Schramm, and Paul Teetor.

It was decided that such an Advisory Committee to the Bureau of Standards was worth while and practical, and that the Research Committee of the White Wares Division (Louis Navias, *Chairman*) should take the matter in hand.

A few days later another meeting was held, and it was decided that the working committee should be made as small as possible, but representative of the several whiteware Industrial Subdivisions. This meeting was attended by A. V. Bleininger, E. H. Fritz, R. F. Geller, T. A. Klinefelter, H. M. Kraner, Karl Langenbeck, Louis Navias, H. F. Royal (for F. H. Riddle), and Edward Schramm.

II. Advisory Committee of the White Wares Division

By March 12, 1931, a committee was appointed by the Chairman, and a letter sent to P. H. Bates of the Bureau of Standards giving the personnel and the purpose of its formation, which in part reads:

"The White Wares Division of the American Ceramic Society through its Research Committee has been desirous of making contact with the Ceramics Division of the Bureau of Standards. The tentative objects . . . are to determine the present experimental projects of the Bureau and to be of counsel to the Bureau on future experimental projects considered by the Bureau."

The personnel of the Advisory Committee is as follows:

A. V. Bleininger, semivitreous ware
P. D. Helser, sanitary ware
H. M. Kraner, electrical porcelain
F. K. Pence, tile
F. H. Riddle, high-temperature porcelains
E. Schramm, vitreous ware
K. Langenbeck (at large)
L. Navias, *Chairman*

* Chairman, Feb., 1931, to Feb., 1933.

III. Consideration of Problems

A two-day meeting was called for May 8 and 9, 1931, to take place in Washington, D. C., to confer with the Bureau on the question of problems. As a basis for the discussion the Bureau had previously sent to the members a résumé of work on whiteware undertaken in 1930, and a list of titles of papers relating to whiteware as published by the Bureau.

The meeting was attended by Messrs. Bleininger, Kraner, Riddle, Schramm, Langenbeck, and Navias, Chairman of the Committee, and by Messrs. Bates, Geller, and Klinefelter of the Bureau. A list of 28 problems was made, five of them being under way at Columbus, three problems under way at Washington, and the remainder for consideration and future investigation. The problems of a more fundamental nature were considered of first importance. Due to the long duration of time required in the study of these problems, it was decided to have included also some short problems of a more practical nature.

The problems then under way at both the Columbus and Washington Stations were as follows:

Problem No. 1:	gases evolved by feldspar at high temperatures
Problem No. 2:	reaction of clays to water vapor in the autoclave
Problem No. 7:	a comprehensive study of English china clays
Problem No. 8:	a study of the glass phase in whiteware bodies, including vacuum melting treatment
Problem No. 23:	occurrence and effects of salts in clays on working properties
Problem No. 5:	a study of low-temperature maturing bodies
Problem No. 9:	X-ray studies of commercial bodies
Problem No. 27:	changes in clays and other hydrated aluminum silicates due to heating

By correspondence, the Bureau decided to consider two short problems of an empirical nature. These were No. 13 on the factors affecting the dipping qualities of glazes (especially raw glazes) and No. 24 on the effect of reheating electrical porcelains on physical properties. Accordingly correspondence was addressed to the industry to submit the facts and to supply samples and test specimens.

IV. Progress Report, Washington Meeting, February, 1932

A meeting was held with Messrs. Bleininger, Helser, Kraner, Riddle, Schramm, Langenbeck, and Navias, Chairman of the Committee, and by Messrs. Bates, Geller, and Klinefelter of the Bureau, present.

Progress was reported as follows:

Problem No. 1 on gases evolved by feldspar on heating; report had been completed, and was being printed.

Problem No. 7 on English china clays had been completed; study was being extended to include seven typical domestic kaolins.

Problem No. 5 on a study of low-temperature maturing bodies, was nearing completion.

Problem No. 27 on changes in clays and other hydrated aluminum silicates due to heating; petrographic work was being pursued.

Problems Nos. 3 and 15 were considered a part of the more general problem, No. 20, in which the ternary system K_2O–PbO–SiO_2 was to be studied as part of the glaze investigation; a preliminary survey was under way.

Problem No. 24 on the change in physical properties due to refiring of electrical porcelain. By means of correspondence between the Committee and the Bureau, the kind of tests to be made, the shape of specimens required, and the number of refirings were decided. Four companies had promised specimens, and at the Washington Meeting two concerns had already sent in their samples to the Bureau. The coöperation was stimulating to all concerned.

Problem No. 13 on the factors affecting the dipping qualities of raw glazes. A questionnaire worked out by the Committee and the Bureau was sent to 17 concerns, from whom 12 replies were received. Only 7 concerns considered an investigation desirable as follows: vitreous ware 2, semivitreous ware 3, electrical porcelain 2, sanitary porcelain 0. After discussion it was decided to put this problem aside.

Problem No. 29 on effect of grain size of feldspar and flint on whiteware bodies. This was a new problem, decided upon for immediate work, and involving separation of particles into fractions by means of an air elutriator.

It was decided to avoid publicity until the work on some definite problem had been completed—probably at the 1933 Meeting.

V. Progress Report, Pittsburgh Meeting, February, 1933

The Bureau has reported the following status of work and reports as follows:
Reports published during the year 1932:

"Thermal Expansion of Some Silicates of Elements in Group II of the Periodic System."
"Moisture Expansion of Ceramic Whiteware."
Problem No. 5 on "A Study of Some Ceramic Bodies of Low Absorption Maturing at Temperatures below 1000°C."
Problem No. 24 on "Effect of Repeated Heatings on the Mechanical Strength of High Tension Insulator Porcelains." This paper was read at the Pittsburgh Meeting.[1]
Problem No. 1 on "Gases Obtained from Commercial Feldspars Heated in Vacuo."
Investigations under way at the Bureau of Standards, at both the Columbus and Washington Stations are as follows:
Problem No. 29 on "Particle Size Fractions of a Flint and a Feldspar and Their Effect on Whiteware Bodies." Data obtained thus far on bodies made with several fractions were presented at the Pittsburgh Meeting.
Problem No. 20 on the "Phase Equilibrium Diagram for the System K_2O–PbO–SiO_2." Work is now being carried on in the PbO–SiO_2 system, and in the high silica region of the ternary system.
Problem No. 8 on the "Glass Phase in Fired Clay Materials." A cone study of the system K_2O–CaO–Al_2O_3–SiO_2 has been completed, the section bounded by the 50 and 80% SiO_2 levels being investigated. A brief summary may be given as follows:
"The 50% silica level shows very refractory areas at 20–25% K_2O, 5–10% CaO, and 15–25% Al_2O_3; and at 5% K_2O, 15% CaO, 30% Al_2O_3. In addition to the high potash area, there is another low-melting region at 5% K_2O, 20% CaO, and 25% Al_2O_3. Both the refractory and the low-melting regions extend (as volumes) up to the 60% silica level.
"Clear glasses are formed as long as the percentage of alumina does not exceed 10% and the lime content 20%, the limit for alumina decreasing with increasing lime content."
Problem No. 7 on investigations and comparisons of English china clays and American kaolins. The work on fifteen English china clays has been completed and the report is ready for publication. This paper was read at the Pittsburgh Meeting. Work is proceeding on the American kaolins.
The Chairman wishes to record his appreciation of the coöperation of the members of the Advisory Committee, of the concerns who were asked for samples, information, and advice, and of the Director and staff of the Bureau of Standards, during the two years of the existence of this coöperative grouping.

LOCAL SECTION ANNUAL REPORTS

Baltimore-Washington Section

This section holds regular meetings which are announced in the *Bulletin of the American Ceramic Society*. The officers of the Section are as follows:

Chairman: R. F. Geller, Bureau of Standards, Washington, D. C.
Vice-Chairman: Richard H. Türk, Porcelain Enamel & Mfg. Co., Baltimore, Md.
Secretary: W. R. Lester, Maryland Glass Corp., Baltimore, Md.
Councillor: W. N. Harrison, Bureau of Standards, Washington, D. C.
Chairman, Program Comm.: Joseph F. Klekotka, Bureau of Standards, Washington, D. C.

The Section has a paid membership of forty and a mailing list of approximately 110 persons.
Three meetings are held each year, normally, alternating between Washington and Baltimore. The average attendance is about thirty-five. These meetings include

[1] R. F. Geller, *Bull. Amer. Ceram. Soc.*, **12** [1], 18 (1933).

a dinner and the reading of one or more papers, including scientific, technical, and practical subjects.

The Chairman states that in regard to finances "there are no red ink stains on the treasurer's fingers—yet."

Chicago Section

The Secretary of the Chicago Section offers information regarding the work of this Section for 1932–1933. The officers elected in January, 1932, are as follows:

Chairman: A. G. Johnson, Western Electric Co., Chicago.
Vice-Chairman: F. E. Hodek, Jr., General Porcelain Enamel & Mfg. Co., Chicago.
Secretary: H. V. Kaeppel, *Ceramic Industry*, Chicago.

One business meeting was held and also the annual golf tournament in June.

There are ten paid memberships at this time, although normally the Section has a membership of about twenty-five persons.

The Chicago Section has appointed the following committee to assist with arrangements for the Summer Meeting of the Society during Engineers' Week at the Century of Progress in June, 1933: R. A. Beverly, *Chairman:* F. E. Hodek, Jr., G. G. Hanson, E. W. Woodruff, A. G. Johnson, L. I. Shaw, F. L. Steinhoff, and H. V. Kaeppel.

This Committee is making arrangements for hotel reservations at the Stevens Hotel for the week of June 25. A registration room has been secured and the Committee is securing representation of the American Ceramic Society on programs which are being planned for Engineers' Week.

The Chicago Enamelers' Club, an organization not connected with this Society, has active monthly meetings in that city.

Pacific Northwest Section

The 11th annual meeting of the Pacific Northwest Section was held at Mines Hall, University of Washington campus (Seattle), February 25, 1933, with President G. L. Rogers presiding. After an address of welcome by Dean Roberts of the College of Mines, the following program was given.

(1) "California Roof Tile," by Ross Plank, Gladding, McBean, and Company
(2) "Reinforced Brick Masonry," by W. J. Howard, P. N. W. Brick & Tile Association
(3) "The Thompson Continuous Filter Press," by R. M. Thompson, Thompson Machine Co.
(4) "De-Airing Methods and Equipment," by W. W. Kriegel, Gladding, McBean, and Company.
(5) Reports from the University of Washington
  (*a*) "Permeability Tests of Brickwork," by H. F. MacDonald
  (*b*) "The Slagging Action of Fuel-Oil Ash," by L. R. Faulkner
  (*c*) "Quartz Sands and Mica in the P. N. W.," by F. J. Zvanut
  (*d*) "Microscopic Examination of Whiteware Bodies and Glazes," by G. J. Middleton
  (*e*) "Geology of the Northern Cascade Mountains with Reference to Buff-Firing Clays," by K. G. Skinner.

The annual banquet was held in the evening at the Hotel Meany.

The following officers were elected for the year 1933:

President, Hewitt Wilson, College of Mines, University of Washington
Vice-President, O. K. Edwards, Willamina Clay Products Company, Willamina, Oregon
Treasurer, H. O. Thompson, Builders' Brick Company, Seattle
Secretary, Samuel Geijsbeek, Geijsbeek Engineering Company, Seattle
Councillor, Dean Milnor Roberts, College of Mines, University of Washington.

The treasurer reported a bank balance of $146.08. A letter from General Secretary Purdy, concerning the ceramic exhibit at the Chicago Century of Progress Exposition was read. A bill providing for the necessary funds to collect and ship an exhibit from the State of Washington is before the Washington State legislature and it will be neces-

sary to await their action before preparing a ceramic exhibit. Henry A. Burd, professor of business administration, University of Washington, delivered the address of the evening on "Market Analysis." Clifford Houlahan and H. O. Thompson of the Builders' Brick Company engaged in a remarkable tie-cutting contest and Hewitt Wilson said more than necessary in "Let Nature Take Its Course." Resolutions were passed to urge the national government to continue coal and nonmetallic research work at the Northwest Station of the U. S. Bureau of Mines, to approve the excellent work of Scott Turner as Director, and to deplore a possible transfer of the Bureau of Mines from the Department of Commerce to the Department of Interior. Approval was given for the use of an old balance in the building code fund for the publication of a paper by W. J. Howard, on certain problems concerning masonry construction and suggested specifications for brick and tile.

Since the last meeting six papers have been published by members of the Section.

(1) J. A. Cunliffe and H. E. Clem, "Refractories for Use in Sulphate Recovery Furnaces of the Pulp and Paper Industries," *Jour. Amer. Ceram. Soc.*, **15** [6], 321–33 (1932).

(2) H. Wilson, "Buckling of Wall Tile," *ibid.*, **15** [4], 252–60 (1932).

(3) H. Wilson and G. A. Page, "A Simple Dispersion Test for Clays," *ibid.*, **16** [2], 82–85 (1933).

(4) T. E. Nicholson, "Discoloration of Terra Cotta Glaze," *ibid.*, **15** [7], 386–88 (1932).

(5) F. J. Zvanut, "Purification and Utilization of P. N. W. Quartz and Muscovite Mica" (abstract), *Ceram. Ind.*, pp. 94 and 97 (1933).

(6) K. G. Skinner, "Action of Waste Wood and Oil Fuel on Refractories" (abstract), *Brick Clay Rec.*, pp. 204 and 215 (1932); to be published in full in *Jour. Amer. Ceram. Soc.*

This list completes 36 publications from the Ceramic Department of the University of Washington since 1920. Forty-five papers have been mimeographed and distributed by the Section since its organization in 1923.

The following ceramic and nonmetallic reports have been accepted for publication:

(1) H. Wilson, G. A. Page, and V. S. Cartwright, "Dewatering Clay Suspensions by Spray Evaporation," Bur. Mines *Tech. Paper*, 1933.

(2) H. Wilson and J. A. Cunliffe, "The Refining of P. N. W. Kaolins by Air Flotation," *Jour. Amer. Ceram. Soc.*, **16** [3], 154 (1933).

(3) H. Wilson, "Iron-Oxide Mineral Pigments of the U. S.," Bur. Mines *Bull.*, 1933.

The ceramic and nonmetallic research studies under way at the University of Washington not mentioned above are listed on p. 112, this issue of the *Bulletin*.

Those attending the annual meeting were as follows: J. Geo. Adderson, Ross Plank, G. L. Rogers, W. E. Lemley, Louis Miller, A. P. Corson, D. McConnell, J. C. Hoski, *Gladding McBean, & Co.;* Gordon Adderson, Kenneth G. Skinner, H. F. MacDonald, Jesse Wilkinson, Joe Daniels, H. A. Burd, Hewitt Wilson, Milnor Roberts, L. R. Faulkner, G. J. Middleton, *University of Washington;* O. K. Edwards, H. G. Wilcox, H. K. Hadley, *Willamina Clay Products Co.;* Samuel Geijsbeek, *Geijsbeek Engineering Co.;* H. F. Yancey, *U. S. Bureau of Mines;* Wm. Rueter, *Strandberg & Rueter, Engineers;* H. O. Thompson, *Builders' Brick Co.;* others from Seattle were F. W. Crary, Wurth Kriegel, H. R. N. Boddy, W. J. Howard, M. E. Reynolds, Frank Lohse, John B. Stirrat, R. M. Thompson; from Everett, Wash.: R. L. Bridges, Burt Shaffer, Robert Shaffer; and Fred Kettenring, Jr., Vancouver, Wash.

Pittsburgh Section, April Meeting

Members of the Pittsburgh Section will hold a meeting on April 11, 1933. William Steriker, Chief Chemist of the Philadelphia Quartz Company, will talk on "Sodium Silicates in the Ceramic Industries." The meeting will be held at 8 P.M. in the Fellows Room, Mellon Institute.

Although this Section does not have a survey of its activities in this group of notices, the members hold regular meetings, and the organization displayed by its members in connection with the Pittsburgh Meeting of the American Ceramic Society prove it to be one of the most alert and well-organized of our Local Sections. Activities of this Section will be found in the 1932 issue of our *Bulletin* on pages 139, 159, and 260.

St. Louis Section

The officers of the St. Louis Section are as follows:

Chairman: Frederick E. Bausch, 1425 Chemical Bldg., St. Louis, Mo.
Secretary: Jos. W. Wright, Owens-Illinois Glass Co., Alton, Ill.
Treasurer: Henry W. Perry, 5900 Manchester Ave., St. Louis, Mo.

One of the 1932 meetings of this Section was held at the Melbourne Hotel. David E. Gray, Chief Engineer, Corning Glass Works, gave an address on "Technical Glassware," and George Aurien, Manager and Superintendent of the Mississippi Glass Company, St. Louis, Mo., talked on "The Modern Method of Rolling Glass."

Ladies and outside guests were included in the plant visit of the St. Louis Section to the A. P. Green Fire Brick Company.

On February 4, 1933, the members of the section with ladies and other guests held a plant visit to the Alton Box Board & Paper Company, Alton, Illinois. Dinner was later served at the Alton Country Club.

RESEARCH STUDIES AT THE CERAMIC SCHOOLS

The New York State College of Ceramics

(At Alfred University)

Major E. Holmes, Dean of the Department of Ceramic Engineering, states that the following subjects are under investigation by the students at the New York State College of Ceramics. Only four hours each week are spent on this work and Dr. Holmes states that for this reason the projects are not very ambitious. If one of the problems listed is worked out in adequate measure for publication, he feels that the efforts will be justified.

In addition to research being conducted by Sandford S. Cole, senior students are working on the following problems:

(1) The catalysis of the reaction between lime and silica.
(2) The development and control of a desirable brick scum.
(3) The relation between the green and fired porosity of silica brick.
(4) Study of the properties induced in glazes by various oxides: (*a*) thermal expansion coefficients, (*b*) tensile strength coefficients, (*c*) elasticity, and (*d*) analytical work for above.
(5) The properties of cristobalite in bodies.
(6) The production of glazes for a particular brick clay.
(7) Study of the absorption of various liquids by clay bodies.
(8) The production of a yellow-green vitreous china body.
(9) Study of glaze effects secured from heat-treated micas held in suspension.
(10) The effects of reheating on the P. C. E. of refractories.

Ohio State University

The following research topics are being conducted at Ohio State University under the supervision of A. S. Watts, head of the Ceramic Engineering Department and his associates.

(A) Fundamental studies in ground coats.
  (1) Mechanics of enamel adherence: (*a*) crystal formation at interface; (*b*) tests for adherence.
  (2) Raw materials and composition: (*a*) special studies of adherence promoting oxides; (*b*) development of white ground coats.
  (3) Special methods of firing: (*a*) in various gases; (*b*) *in vacuo;* (*c*) by various temperature schedules.
  (4) Defects in ground-coat enamels: (*a*) reboiling and other gas defects; (*b*) fish-scaling.
(B) Studies in enamel slip conditioning.
  (1) Methods of determining consistency.

(2) Effect of various electrolytes.
(3) Effect of various clays.
(C) Refractory investigations.
(1) Checker brick.
(2) An exhaustive fundamental study of refractory cements.
(D) Investigation of talc as a ceramic body ingredient.
(E) Studies in the whiteware field.
(1) The potash-soda-lime feldspar system: (*a*) deformation study; (*b*) microscopic and X-ray study of the fusions; (*c*) application of various potash-soda-lime feldspar mixtures as ceramic fluxes.
(2) The feldspar–kaolin–quartz system (Part B): (*a*) deformation study of the field 0 to 50% feldspar–0 to 50% kaolin–0 to 50% flint; (*b*) other physical properties of these mixtures.
(3) Control of physical properties of casting slips: (*a*) influence of composition of silicate of soda on its action as an electrolyte; (*b*) influence of preparation process on the properties of a typical casting slip.
(4) Auxiliary fluxes: (*a*) solubility of various oxides in typical feldspars; (*b*) effect of various low fusing glasses on the properties of typical feldspars.
(5) Study of grain size of feldspar and flint: (*a*) effect on their physical properties alone and in ceramic bodies; (*b*) fractionation of nonplastic powders.
(6) Study of hotel china in service: (*a*) causes of deterioration of decoration and glaze; (*b*) causes of chipping in service.
(F) Studies in the ceramic equipment field.
(1) A laboratory drier for ceramic research.
(2) Fundamental research in kiln design.

University of Washington .

The following research studies are being conducted by the Ceramic Engineering Department of the University of Washington, Seattle, Wash. The first five studies indicate coöperative work with the Northwest Station of the U. S. Bureau of Mines.

(1) A study of the kaolins and whiteware materials of the Pacific Northwest. Then kaolins are being studied for whiteware, paper filler, and for kaolin fire brick.
(2) The Chalks and whitings of the United States.
(3) The dewatering of kaolin suspensions by spray evaporation.
(4) The purification of kaolin rock by pneumatic methods.
(5) The study of the quartz sands of the Pacific Northwest for use as foundry sand, potters' flint, etc.
(6) Studies of mat glazes.
(7) The packing of particles for refractories and terra cotta.
(8) Petrographic studies of porcelain, china, and earthenware bodies.
(9) Low-temperature bodies using Pacific Coast talc and soapstone.

Hewitt Wilson Director of the Ceramic Engineering Department has requested the coöperation of companies manufacturing vitrified hotel ware and earthenware products in making check tests of the Pacific Northwest kaolins.

Virginia Polytechnic Institute

John W. Whittemore, Professor of the Department of Ceramic Engineering, Virginia Polytechnic Institute, gives the following list of research studies being conducted at that school:

(1) Comparative strengths of slabs constructed of reinforced brick and reinforced concrete.
(2) Measurement of the plasticity of clays. This work is being done on several different clays of evident varying plasticity. The amount of water added, the application of the load, and the time-interval of loading are varied for the tests.
(3) The relation of grain size to the plastic properties of limes.
(4) The effect of additions of tannic acid on the physical properties of some Virginia clays and shales. This experiment is being conducted both in the laboratory and in brick plants.

AMERICAN CERAMIC SOCIETY STUDENT BRANCH ACTIVITIES ANNUAL REPORT

Emerson P. Poste, president of the Society for 1932–1933, as part of his activities, requested a report from each of the ceramic schools on the student activities and meetings which are related to the American Ceramic Society.

Iowa State College

The first of these reports is offered by Paul E. Cox, Head of the Department of Ceramic Engineering, who writes in part as follows:

Owing to the fact that enrollments in our department are few, we require all students after the freshman year to attend a weekly meeting scheduled generally on Thursday at 11 A.M. This method insures attendance and attention on the part of the entire group of students who are old enough to profit by a knowledge of the aims and purposes of the American Ceramic Society.

In addition, all engineering departments require a weekly meeting which is described under the term "seminar." The various student activities are discussed as well as the work of the Student Branch of the Society.

The president of the Student Branch automatically becomes a member of the Engineering Council which is a body handling the activities business for the Engineering Division. The vice-president, a junior student, becomes automatically president in the next year, and he likewise is a member of the Council.

The ceramic students have a lively organization at Iowa State College, even though the department is small. This group has been one of the best of the departments on the campus in advertising the profession which it represents. This fact is proved during the annual spring festival, Veishea, where the floats are entered in a prize contest and an "open-house" show is offered to entertain the general public. The ceramic show is one of most enjoyable and the ceramic students have a good reputation for being successful hosts.

At their meetings each student is called on for the presentation of some talk concerning some phase of the ceramic business.

One of the best things that the American Ceramic Society has done is to furnish membership cards which are prized by the young men and which cost them nothing (and, of course, costs the Society nothing). In addition to this local activity, nearly all students become student members of the Society at a fee of $5.00. The local branch of students is really a distinct unit from this student membership, since the students enroll as individuals in the national organization.

It is unusual to require membership in this phase in a technical society, but I have found that the students appreciate this requirement, and handled as it is in the regular day's work, with time allowed for it, no hardship is suffered by the arrangement.

New York State College of Ceramics

(At Alfred University)

F. W. Muller, president of the Student Branch offers the following description of the organization and activities of the students at the New York State College of Ceramics:

There are fifty-five student branch members and two of these are members of the American Ceramic Society. In the Departments of General Technology Engineering and Glass Technology, there are 163 students registered.

The program outline for the year 1932–1933 is as follows:

(1) October 18, 1932. "The Winning of Florida Clays," illustrated by motion pictures from the Edgar Plastic Kaolin Company, by Tom Falknor.

(2) November 9, 1932. "Dolomite Refractories," by M. E. Holmes, Dean of the Department of Ceramic Engineering. This talk was also illustrated by movies.

(3) February 7, 1933. "Glassmaking Processes," illustrated with slides and presented by S. R. Scholes, Head of the Department of Glass Technology.

(4) Other meetings will include reports on the Annual Meeting of the American Ceramic Society in Pittsburgh, 1933, a program sponsored by the Keramos fraternity, and addresses by outside speakers to be announced later.

The officers for 1932–1933 are as follows: *President*, F. W. Muller, *Vice-President*, Whitney Kuehn, *Secretary*, B. J. Towner, and *Treasurer*, Vincent Wessels.

At the present time the Student Branch is undertaking no collective investigation on any given subject.

Ohio State University

Arthur S. Watts, Councillor for the Student Branch, Ohio State University, makes the following statement concerning local activities at this school:

The Student Branch at Ohio State University held seven meetings during the year 1932, the February meeting being cancelled on account of the Annual Meeting of the American Ceramic Society. The speakers were as follows:

W. G. France, Colloid Chemistry Dept., O. S. U. Campus. *Subject:* "The Setting of Plaster of Paris."

C. B. Harrop, Harrop Ceramic Service Co., Columbus, Ohio. *Subject:* "The Future of the Brick Industry."

Richard Bradfield, Soils Department, O. S. U. Campus. *Subject:* "Colloidal Fractionation of Clays."

A. S. Watts, Ceramic Engr. Dept., O. S. U. Campus. *Subject:* "Contributions of Ceramics to Civilization—Pottery."

S. M. Jenkins, Armstrong Cork & Insulation Company, Beaver Falls, Pa. *Subject:* "Heat Insulation and Its Use in Ceramic Structures."

H. D. Callahan, Northwestern Terra Cotta Company. *Subject:* "The Future of Terra Cotta."

H. B. Henderson, Standard Pyrometric Cone Company, Columbus, Ohio. *Subject:* "Pyrometric Cones and Their Use in Kiln Control."

The officers of this student branch for the 1932–1933 school year are *President*, Eldon G. Constance, *Vice-President*, John F. Herold, and *Secretary-Treasurer*, Wm. N. Tinsley.

For the year 1932–1933, there are 99 students enrolled in the Ceramic Engineering Department, including 20 graduate students. Of this number, 30 are members in good standing in the Student Branch. Four Student Branch members are also members of the American Ceramic Society.

Pennsylvania State College

George J. Bair, Assistant Professor of Ceramics, submits a report on the activities of the Student Branch at Pennsylvania State College.

(1) The Penn State Ceramic Society consists of 23 members. All students enrolled in the ceramic curriculum automatically become members of the society. There are no dues required.

(2) The present enrollment in ceramics at Pennsylvania State College is twenty-two undergraduates and one graduate student.

(3) Two members of the local society are also student members of the American Ceramic Society.

(4) The purpose of the Penn State Student Ceramic Society is to promote good fellowship among the ceramic students of all classes and to acquaint the students with the scope and development of the ceramic industries.

Dinner meetings to which a guest speaker is invited are held each month. The guest speaker is obtained by the department from the members of the college faculty, or when possible, a ceramic operator or research man from the field. Two or three additional talks, reviewing recent developments in ceramics, are given by student members.

The organization is entirely governed by the students and their fine spirit and co-operation have made the society add greatly to their ceramic training.

(5) The officers for the present year are *President*, R. E. Griffiths, *Vice-President*, H. R. Custer, *Secretary-Treasurer*, D. G. Samuel, and *Chairman of Program Committee*, H. R. Custer.

Rutgers University

John C. Leavy, President of the Rutgers Student Branch, presents the following information concerning the activities of his group:

There are twenty-one members enrolled in the Rutgers Student Branch at the

present time. There are twenty-five students in the Department of Ceramics, and several of these are student members of the American Ceramic Society.

This Student Branch holds regular monthly meetings in the Ceramics Building. The first meeting of the school year is devoted to the initiation of freshmen members. Prominent men from the ceramic industry are secured as speakers for the meetings. One meeting each year is devoted to ceramic art and students from the New Jersey College for Women, and Extension Courses in Ceramic Art are guests.

The Student Branch takes an active part in the arrangements for the Ceramic Expositions given at the University. These Expositions have been well attended and have greatly increased the interest in and knowledge of the ceramic industry.

The next Exposition will be held in May, 1933, and the Student Branch is making arrangements for active part in this work.

One social event, at which the students and their friends are the guests of the Department of Ceramics, is held each year. The students have been encouraged and helped by the support of former members who return regularly for the meetings and take an active interest in the group.

The officers are *President*, John C. Leavy, *Vice-President*, Arthur M. Hossenlopp, *Treasurer*, H. H. Frahme, *Secretary*, Chester Gulick, *Councillors*, George H. Brown and R. G. Mills, professors of the Department.

School of Mines and Metallurgy, Rolla, Missouri

C. M. Dodd, Acting Head of the Department of Ceramics at this School has presented the following data on student activities at Rolla:

There are twenty-three students in the ceramic department this year (1932–1933) and every member of the department is considered a member of the Orton Society. This Society functions as a student branch of the American Ceramic Society. At present two Orton members are also student members of the American Ceramic Society.

The program of activities for the year may be enumerated as follows:

(1) Since the birthday of the late General Edward Orton, Jr., falls on October 8, it was decided to commemorate this day as befitting a man of his ability and outstanding accomplishment. Orton Day, therefore, has been made a permanent institution, with a banquet and suitable addresses provided for the occasion. (The Orton Society hopes that this movement will be practiced by other student branches in the country.)

(2) The meetings of the Orton Society are held on alternate Wednesday nights. The program for this year has been a survey of the ceramic field. In refractories, a brief history of the industry was given by a senior student, followed by a talk on the opportunities open in this field for ceramic engineers. At this meeting a motion picture of the manufacture of refractories was shown through the courtesy of the Bureau of Mines. At subsequent meetings, various research papers on refractories as published in the *Journal* of the Society were presented and discussed. Other phases of ceramics will be treated in a similar manner during the remainder of the year.

(3) Election of officers of the Orton Society is held at mid-year. This method was adopted so that at the opening of the school year in the fall men familiar with the duties of the various offices are active and afford an inspiration to new students as they take their places in the organization. The outgoing officers for 1932 are *President*, Robert S. Green, *Secretary-Treasurer*, Kenneth F. Scheckler.

The new officers for 1933 are as follows: *President*, Kenneth F. Scheckler, *Vice-President*, A. W. Beinlich (reëlected), and *Secretary-Treasurer*, Oliver W. Kamper.

University of Illinois

J. C. Swartz, Secretary-Treasurer of the University of Illinois Student Branch writes that there are forty-eight members in this organization. The department of Ceramic Engineering has fifty-nine members, exclusive of freshmen. The officers for the year 1932–1933 are *President*, E. G. Porst, *Vice-President*, W. P. Keith, and *Secretary-Treasurer*, J. C. Swartz.

For the program activities of the first semester there were two speakers and one educational film. The program proposed for the second semester is as follows:

February: C. W. Parmelee and A. I. Andrews, "Report of the Meeting of the American Ceramic Society."

March: Moving picture of the relation of the Anaconda Zinc Oxide Department of the International Lead Refining Company to the ceramic industry.

April: J. H. Chesters, "Refractory Linings for Electric Furnaces." Dr. Chesters is a graduate student in the Department of Ceramic Engineering, studying the "Firing of Magnesite Brick." He is being here for two years on a Commonwealth Fund Fellowship.

Plans are being made for a one-day trip to Lincoln and Morton to inspect the potteries in the two towns. The trip will be open to Juniors and Seniors.

May: "Pig Roast." The annual banquet of the Student Branch. Robert D. Landrum, Sales Manager of the Harshaw Chemical Company, specialist in vitreous enamels, will be the principal speaker. Tentative date May 3, 1933.

University of North Carolina
State College of Agriculture and Engineering at Raleigh

A. F. Greaves-Walker, Councillor for the Student Branch at North Carolina State College, makes the following statement of the history of this group and its present activities:

Organized in the fall of 1925 this Branch has just finished its seventh year. It has always been an active organization and the center around which practically all of the activities of the Department have centered.

Its monthly meetings are of the usual kind for this type of student organization, the programs consisting of talks by students and faculty and occasionally by outsiders. In addition this Branch has each year sponsored the exhibit put on by the department during the annual Engineers' Week at the College.

The Branch has been particularly fortunate in having good officers. The set-up of the Engineers' Council automatically makes the presidents of the technical societies members of that organization and at the same time requires that they be the outstanding men in the various departments. This has made for splendid leadership and has made it unnecessary for the Faculty Councillor to "carry" the organization.

At the time of this report the membership of the Branch was 28, and the registration in the department was 35. Freshmen are admitted as associate members and elevated to full membership at the end of the spring term.

Three Student Branch members are members of the parent Society as student members.

On December 6, President E. P. Poste made an official visit to the Student Branch and presented to it the Society's Charter. The ceremony of presentation was preceded by a dinner attended by the full membership and a number of alumni. Mr. Poste was presented with a vase made by members of the Branch as a memento of the occasion.

As a means of advertising the department the Student Branch last spring put on two exhibitions of art pottery made by members outside of class hours. One of these, consisting of approximately 100 pieces was at the Woman's Club and the other in the show windows of merchants in the down-town shopping district. Both exhibits received high praise from the newspapers and townspeople. Another exhibit of the kind is to be made this spring.

The department's part in the annual pageant put on during Engineers' Week is sponsored by Keramos as is one or more research projects carried on in the department each year.

The officers for the academic year 1931–1932 are as follows: *President*, George J. Grimes, *Vice-President*, Walter B. Boyd, *Secretary-Treasurer*, D. L. Bohannon, and *Councillor*, A. F. Greaves-Walker.

University of Washington

Hewitt Wilson, Head of the Department of Ceramic Engineering at the University of Washington, writes that there is no regular student branch organization at his school. The ceramic and mining students together have formed a Mines Society which meets at noon every other Friday.

There are nine ceramic engineering students this year in the junior, senior, and graduate classes. The first two years are identical in all engineering groups. There are also sixteen special students from other departments taking ceramic engineering courses.

The officers of the Mines Society are *President*, Philip Holdsworth, *Secretary*, Jean

Horning, *Treasurer*, Fred Wise, and *Senior Representative on the Engineering Council*, George Middleton.

The ceramic programs have included W. L. Howard, Secretary of the Pacific Northwest Brick and Tile Association on "Recent Developments in Ceramic Building Materials," and R. D. Plank, ceramic chemist for the Gladding, McBean and Company, on "The Manufacture of Roofing Tile in California." The moving picture, entitled, "The Preparation of Florida Kaolin," by the Edgar Plastic Kaolin Company, was likewise shown at one of the meetings.

An excellent display of exhibits was made by the ceramic engineers in the 1932 Engineers' Open House held last April on the campus. Demonstrations of pottery casting and throwing, enameling metals, spraying, firing as well as exhibits of all types of ceramic products and the non-metallic minerals were made in the Mines building.

The special group research problems for this year include: The development of both porous and dense kaolin fire brick from Washington kaolins; the continuation of the study devoted to the cause of mat glazes, the testing of the new Japanese hotel china which has recently been imported into this country and the microscopic examination of several samples of Imperial Russian chinaware.

INFORMAL RECEPTION AND SMOKER BY OFFICERS OF THE AMERICAN CERAMIC SOCIETY TO STUDENT DELEGATES

List of Registrants, February 13, 1933

New York State College of Ceramics (Alfred University)

S. R. Scholes, Head Dept. Glass Technology

C. M. Harder, Instructor
C. R. Amberg, Instructor
Eugene R. Crandall
Van R. Ostrander
F. W. Muller
Leonard Breeman, Jr.
M. J. Rice
Robert M. Razey
W. J. Merck

Ohio State University

James M. Cayford
Cecil H. Turner
E. D. Riebel
Paul Cecil
James L. Miller
William N. Tinsley
Howard G. Burlingame
Miss Joe Gitter
Joseph W. Moss
Baird L. Dorsey
Arthur J. Metzger
Paul L. Radcliffe
Joe Boehler

Pennsylvania State College

Nelson W. Taylor, Head of Department
George J. Bair, Instructor
Ronald E. Griffiths
Hillard A. Smith
B. T. Jacobs
Roy S. Maize
Ralph L. Gibson
Donald G. Samuel
John Rutherford
Richard E. Robinson
Harold R. Custer
T. M. Fairchild

University of Toronto

R. J. Montgomery, Head of Department

Tulane University Newcomb School of Art

Kenneth E. Smith, Instructor

MISCELLANEOUS CERAMIC SCHOOL NEWS

I. FIRST ANNUAL MINERAL INDUSTRIES CONFERENCE

University of Illinois, March 3 and 4, 1933

The "ceramic winter course" has become a feature at the University of Illinois. It was begun in 1904 in connection with meetings of the Illinois Clayworkers' Association.

Progress in ideas is expected at universities. This conversion of the biennial winter course into a Mineral Industries Conference is in keeping with present-day ideas of combining kindred activities and interest.

The Ohio State University Department of Ceramic Engineering is now a part of a group known as the "mineral industries" in the College of Engineering.

At Pennsylvania State College the Ceramic Department is in the College of Mineral Industries, which college is separate and distinct from the College of Engineering.

General sessions and separate sessions for coal and ceramics were held at the Illinois Conference. Joint banquet and laboratory inspection trips were held.

Notwithstanding the critical banking and economic situation, this Conference was well attended and the meetings were found to be of value to those present.

II. EXHIBIT OF AMERICAN TABLEWARE AT OHIO STATE UNIVERSITY*

In line with the national movement, "Buy American," the Ceramic Engineering Department, Ohio State University, Lord Hall, has arranged a permanent display of American semiporcelain and china tableware.

One display case contains an exhibit of semiporcelain tableware produced by Ohio potteries. Another case contains American lightweight vitreous chinaware suitable for household use, and a third case contained American rolled-edge vitreous chinaware, suitable for hotel and restaurant use.

The progress made by American manufacturers in design of ware in both overglaze and underglaze decoration can only be appreciated by an inspection of this exhibit.

American vitreous china for many years has been world-famous for its durability, and with the beautiful and varied decorations now available, there seems to be no excuse for purchasing foreign tableware.

Lack of space has prevented the display of more than two or three patterns of any manufacturer, but this exhibit definitely justifies the claim that Americans can buy satisfactory tableware.

NECROLOGY

Francis W. Walker, Sr., 1855–1933

Another charter member and a past-president of the American Ceramic Society has died. Francis W. Walker, Sr., passed away Friday, February 17, at his home, Patterson Heights, Beaver Falls, Pa. His wife preceded him in death on August 4, 1932.

Francis W. Walker, Sr., was one of the first to join with W. D. Gates, W. D. Richardson, Ellis Lovejoy, Parker Fiske, and Albert Bleininger in support of the proposal made by Sam Geijsbeek and E. E. Gorton that a ceramic society be organized for the purpose of exchanging and recording technical information. Mr. Walker was among the first to respond to the call of Edward Orton, Jr., for assistance in crystallizing this suggestion into corporate being. Much of the breadth of vision which was written into the initial Constitution and Articles of Incorporation of the American Ceramic Society was credited by Professor Orton to Mr. Walker. It was Mr. Walker who secured the supporting interest of James Pass, Onondaga Pottery Company, of Ernest Mayer, Mayer China Company, of Karl Langenbeck and Herman Mueller, Mosaic Tile Company, of Edward Stover, Trenton Potteries Company, and of William H. Zimmer, Wheeling Pottery Co.

Mr. Walker served as vice-president of the Society in 1903 and was president in 1904. He was a member of the Board of Trustees for two terms of three years each.

Always active, a liberal contributor, socially very genial, his leadership was recognized and sought, but was never urged upon his friends. He was particularly kind and sympathetic and helpful to the young men who were trying to find their most effective places in ceramics.

Mr. Walker was born on May 7, 1855. At the age of 18 years he entered the drug business, serving his apprenticeship in a pharmacy in New Brighton, Pa. Subsequently he studied in Pittsburgh College of Pharmacy (now a part of the University

* Reference is made to a report by A. S. Watts, "The Selection of Dinnerware for the Home," Ohio State Univ., Eng. Expt. Station *Circular*, No. 21 (1930).

of Pittsburgh), and was graduated from this institution in the class of 1882. He had previously purchased a drug store in New Brighton and this he conducted until his entry into the tile business.

The deceased was president of the Beaver County Manufacturers Association, a

FRANCIS W. WALKER, SR.

post he had held for many years. As a representative of western Pennsylvania industries he frequently appeared at hearings of the congressional Ways and Means Committee in Washington, D. C.

He was president of the Beaver County Building & Loan Association for the last quarter century, a director of the Beaver County Trust Company, and a former presi-

dent of the Beaver Falls Chamber of Commerce. Mr. Walker founded the Beaver County Community Chest and was president of the local movement for several years. He was a member of the First Presbyterian Church of New Brighton.

As a charter member of the Beaver Falls Rotary Club, organized in 1919, Mr. Walker served as a director of that organization until impaired health necessitated a cessation of this work a number of years ago. For sixteen years he served as director of the Pennsylvania State Chamber of Commerce and on the day before his death he was elected first vice-president of that Chamber.

During the World War Mr. Walker was a member of the War Industries Board and spent a year in Washington engaged in that work.

Governor Gifford Pinchot once described Mr. Walker as the "Daddy" of the Pymatuning Dam, in commending his efforts in behalf of that project. For many years he had favored the ship canal which would link the Ohio River with the Great Lakes and had worked industriously to bring about the realization of such hopes. Through his activity in bringing together the proper officials, construction work on the new Rochester-West Bridgewater bridge was started, and the long delay in replacing the burned structure ended.

In 1887 Mr. Walker organized the Beaver Falls Art Tile Company, as a limited partnership. As the scope of the Company widened and it became necessary to make a change in this arrangement it was incorporated in 1906. Mr. Walker became secretary, treasurer, and general manager of this Company. He later was elected to presidency of this Company and when the firm became associated with the Rossman Corporation in 1927, Mr. Walker was named Chairman of the Board.

The deceased also served as president of the Robert Rossman Company of New York City and vice-president of the American Sewer Pipe Company.

As executive secretary of the Associated Tile Manufacturers Association for many years and later as its president, Mr. Walker was a leader among floor and wall tile manufacturers. His progressive and aggressive ideas aided greatly in the development of that industry technically as well as in the expansion of tile applications.

Honors were conferred upon Mr. Walker not alone by election to offices in many kinds of business, community, and organization affairs, but also by public tributes. In 1923 Geneva College gave him the honorary degree of Master of Arts. He was a charter member of the Fellows of the American Ceramic Society. Many testimonial dinners have been held in his honor. Mr. Walker lived an active, constructive life, adding greatly to the spiritual, intellectual, and material welfare of every group with which he came into contact. Brotherly love and generosity motivated his acts. Francis W. Walker, Sr., will be greatly missed.

NEW MEMBERS RECEIVED IN FEBRUARY

CORPORATION

National Aluminate Corp., G. J. Fink (voter), 6216 W. 66th Place, Chicago, Ill.

PERSONAL

James Francis Cannon, Box 520, East Liverpool, Ohio; Sales Representative, Kentucky Clay Mining Co.

R. E. Fennessey, 365 E. Illinois St., Chicago, Ill.

John T. Jans, 6545 Epworth Blvd., Detroit, Mich.

F. S. Louie, China Klinwares Mfg. Co., Ltd., Fook Wah St., Cheung Sha Wan, Hongkong, China; General Manager.

Lois Whitcomb Rhead, 4403 Center Ave., Pittsburgh, Pa.

Alfred Paul Thompson, Mellon Institute, University of Pittsburgh, Pittsburgh, Pa.; Industrial Fellow.

Wade R. Willey, 36 Cutler Ave., S. W., Grand Rapids, Mich.; Control Engineer, Kelvinator Corp.

Membership Workers' Record

PERSONAL		CORPORATION	
W. V. Knowles	1	W. K. Carter	1
E. W. Tillotson	1		
Office	5	Grand Total	8
Total	7		

BUYERS' GUIDE

A

Abrasives (Alundum-Crystolon)
Norton Co.

Alorite (Refractory Products)
Carborundum Co.

Alumina (Hydrate and Calcined)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Aluminum Oxide (Fused)
The Exolon Co.
The Vitro Mfg. Co.

Alundum (Refractory Products)
Norton Co.

Ammonium Bifluoride
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Ammonium Carbonate
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Antimony Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

B

Ball Mills
McDanel Refractory Porcelain Co.

Ball Mills (Laboratory Type)
Ceramic Color & Chemical Mfg. Co.

Barium Carbonate
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Batts
Carborundum Co. (*"Carbofrax Alorite"*)
Norton Co. (*Alundum Crystolon*)

Bitstone
Potters Supply Co.

Blocks (Refractory)
Carborundum Co.
Norton Co.

Borax
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Borax Glass
Pacific Coast Borax Co.

Boric Acid (Anhydrous)
Pacific Coast Borax Co.
The Vitro Mfg. Co.

Boric Acid (Crystal, Granular, or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
Pacific Coast Borax Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Bricks (Refractory)
Carborundum Co. (*"Carbofrax Alorite"*)
Norton Co.

C

Carbofrax (Refractory Products)
Carborundum Co.

Carbolon (Refractory Products)
The Exolon Co.

Carbonates (Barium, Lead)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Caustic Soda
Ceramic Color & Chemical Mfg. Co.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cements
Carborundum Co.

Ceramic Chemicals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Chromium Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Ball)
Ceramic Color & Chemical Mfg. Co.
Hammill & Gillespie, Inc.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
The Roessler & Hasslacher Chemical Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (China)
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Edgar Brothers Co.
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Vitro Mfg. Co.

Clay (Electrical, Porcelain)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.
The Vitro Mfg. Co.

Clay (Enamel)
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Metal & Thermit Corp.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay (Fire)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.

BUYERS' GUIDE (continued)

Clay (German Vallendar)
Ferro Enamel Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Clay Miners
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Spinks Clay Co., H. C.

Clay (Potters)
Spinks Clay Co., H. C.

Clay (Sagger)
Edgar Brothers Co.
Kentucky-Tennessee Clay Co.
Paper Makers Importing Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wad)
Kentucky-Tennessee Clay Co.
Potters Supply Co.
Spinks Clay Co., H. C.

Clay (Wall Tile)
Kentucky-Tennessee Clay Co.
Spinks Clay Co., H. C.

Clocks (Gauge Board)
Ferro Enamel Corp.

Cobalt Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Colors
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cornwall Stone
Hammill & Gillespie, Inc.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Cornwall Stone (Imported)
The Roessler & Hasslacher Chemical Co.

Crucibles (Filter, Melting, Ignition)
Norton Co.
Potters Supply Co.

Crystolon (Refractory Products)
Norton Co.

D

Decorating Supplies
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Drying Machinery
Ferro Enamel Corp.

E

Electrical Porcelain
Paper Makers Importing Co.

Enameling Equipment (Complete)
Chicago Vitreous Enamel Products Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Enameling Furnaces
Carborundum Co. (*Carboradiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Norton Co.
Porcelain Enamel & Mfg. Co.

Enameling Iron (Sheet)
American Rolling Mill Co.

Enameling Muffles
Carborundum Co. (*Carbofrax*)
Norton Co. (*Alundum*)

Enameling (Practical Service)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Enamels
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Enamels (Porcelain)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Metal & Thermit Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Equipment (Porcelain Enameling)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

Exolon (Refractory Products)
The Exolon Co.

F

Feldspar
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Fire Brick
Carborundum Co.
Norton Co.

Flint
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co
The Vitro Mfg. Co.

Flint Pebbles
Ferro Enamel Corp.

Floors (Non-Slip)
Norton Co.

French Flint
Paper Makers Importing Co.

Frit
Ceramic Color & Chemical Mfg. Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

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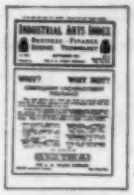

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BUYERS' GUIDE (continued)

Furnace
Carborundum Co. (*Carborodiant*)
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.

G

Glaze and Body Spar
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Glazes and Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Glaze Spar
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Gold
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Grinding Wheels
Norton Co. (*Alundum Crystolon*)

H

Hearths
Carborundum Co.
(*Carbofrax* heat treating)
Norton Co. (*Crystolon*)

Hearths (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.
Norton Co.

I

Iron (Enameling)
American Rolling Mill Co.

K

Kaolin
Ceramic Color & Chemical Mfg. Co.
Edgar Brothers Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Kilns (China, Decorating)
Drakenfeld & Co., B. F.

Kryolith
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

L

Leeds (High Aluminous Clay, Electrically Sintered Aluminum Oxide, Silicon Carbide)
Carborundum Co.

Linings (Furnace Refractory, Block Refractory Plate, Brick and Tile)
Carborundum Co.
Norton Co.

M

Magnesia (Sintered, Calcined)
The Exolon Co.
Norton Co.

Magnesite
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Manganese
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Metals (Porcelain Enameling)
American Rolling Mill Co.

Minerals
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

Muffles (Furnace)
Ferro Enamel Corp.
Carborundum Co. (*Carbofrax*)
Norton Co.

Mullite (Artificial)
The Exolon Co.

Muriatic Acid
Pennsylvania Salt Mfg. Co.

N

Nitrates (Cobalt, Sodium)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.

O

Opacifiers
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

Oxides
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Ferro Enamel Corp.
Metal & Thermit Corp.
Pennsylvania Salt Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

P

Pins
Potters Supply Co.

Porcelain Enameling Service (Practical)
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

Porcelain Enamels
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.

BUYERS' GUIDE (continued)

Potash (Carbonate)
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Pyrometer Tubes (Refractory and Hard Porcelain)
McDanel Refractory Porcelain Co.

R

Refractories
Carborundum Co.
The Exolon Co.
Norton Co.
Refractory Materials
Carborundum Co.
The Exolon Co.
Norton Co.
Rutile
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

S

Saggers
Carborundum Co.
Norton Co.
Potters Supply Co.
Selenite of Sodium
Drakenfeld & Co., B. F.
The Vitro Mfg. Co.
Selenium
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Sheets (Enameling Iron)
American Rolling Mill Co.
Silica (Fused)
The Exolon Co.
Silicate of Soda
Ceramic Color & Chemical Mfg. Co.
Philadelphia Quartz Co.
The Vitro Mfg. Co.
Silicon Carbide
The Exolon Co.
Norton Co.
Silicon Carbide Firesand
The Exolon Co.
Sillimanite (Synthetic)
The Exolon Co.
Slabs (Furnace)
Carborundum Co.
Norton Co.
Smelters
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
Soda Ash
Ceramic Color & Chemical Mfg. Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Sodium Antimonate
Ceramic Color & Chemical Mfg. Co.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Sodium Fluoride
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Spar
Ceramic Color & Chemical Mfg. Co.
Paper Makers Importing Co.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Spurs
Potters Supply Co.
Stilts
Potters Supply Co.
Sulphuric Acid
Drakenfeld & Co., B. F.
Pennsylvania Salt Mfg. Co.

T

Talc
Hammill & Gillespie, Inc.
The Roessler & Hasslacher Chemical Co.
Tanks (Pickle)
Ferro Enamel Corp.
Tile (Refractory)
Carborundum Co. (*Carbofrax*)
Norton Co.
Tile (Wall)
Ferro Enamel Corp.
Paper Makers Importing Co.
Tin Oxide
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Metal & Thermit Corp.
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Titanium
Ceramic Color & Chemical Mfg. Co.
Drakenfeld & Co., B. F.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.
Titanium Oxide
The Roessler & Hasslacher Chemical Co.
The Vitro Mfg. Co.
Tubes (Insulating)
McDanel Refractory Porcelain Co.
Norton Co.
Tubes (Pyrometer)
McDanel Refractory Porcelain Co.
Norton Co.

W

Wet Enamel
Ceramic Color & Chemical Mfg. Co.
Chicago Vitreous Enamel Product Co.
Ferro Enamel Corp.
Porcelain Enamel & Mfg. Co.
The Vitro Mfg. Co.
Whiting
Drakenfeld & Co., B. F.
The Roessler & Hasslacher Chemical Co.

Z

Zirconia
Ceramic Color & Chemical Mfg. Co.
Titanium Alloy Mfg. Co.
The Vitro Mfg. Co.

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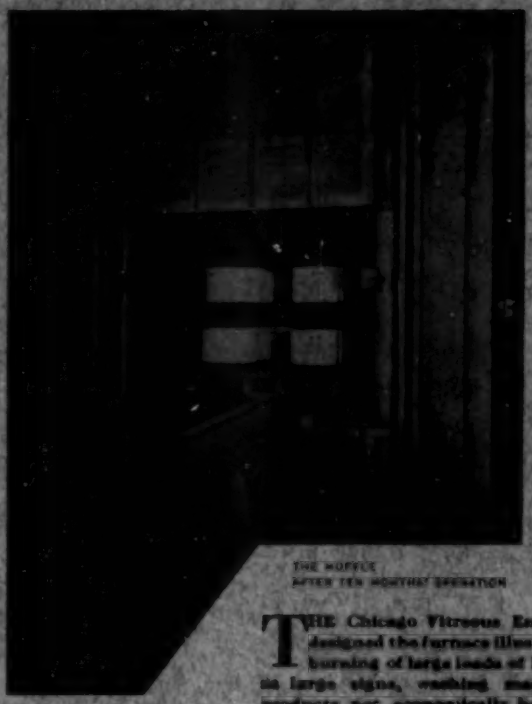

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